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The taxonomy, systematics and ecomorphological diversity of Teleosauroidea (Crocodylomorpha, Thalattosuchia), and the evaluation of the genus '*Steneosaurus*'

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DECLARATION

I hereby declare that the work presented in this thesis is my own and has not been submitted elsewhere. Chapters II and III have been published in esteemed journals (*Historical Biology* and *Zoological Journal for the Linnean Society*, respectively) and are a result of collaboration between myself and colleagues (see chapter prefaces for more information). Both papers, including background readings, descriptions, comparisons, photographs, figures and conclusions, are a representation of my own work.

Sincerely,

Michela M. Johnson

ABSTRACT

Teleosauroidea represented an extraordinary group of crocodylomorphs that thrived in predominately shallow marine environments during the Mesozoic Era. While they have previously been considered as 'marine gharials' of the Jurassic, teleosauroids were in fact morphofunctionally diverse and evolved a bizarre body-plan (which included proportionally enlarged heads and femora). During the Jurassic, they attained a near-global distribution, expanded into various palaeoenvironments and became the first crocodylomorphs to grow to truly large sizes (> 7 m in length). In addition, teleosauroids were one of the first fossil crocodylomorphs to be described (1758) and named (1814), making them a historically important fossil group.

Despite an increase in research over the past decade (particularly for the well-known clade Machimosaurini), the ecology and systematics of Teleosauroidea are still poorly understood and little studied. The question "What is '*Steneosaurus*'?", a waste-basket genus that nearly every teleosauroid species has been placed into at some point, is a taxonomic conundrum that has hampered previous attempts to elucidate and examine teleosauroid evolutionary relationships. To rectify these issues, I examined approximately 550 specimens from 12 countries, and using this material, I created the largest and most comprehensive teleosauroid phylogenetic dataset to date; this dataset includes 502 characters and 153 crocodylomorph taxa (twenty-seven of which are teleosauroids), and was run in both TNT 1.5 and MrBayes 3.2.6.

The results of both the parsimony and Bayesian analyses are consistent with one another, with two large subclades (Teleosauridae and Machimosauridae) within Teleosauroidea recovered; each one is morphologically distinct, with differing biogeographic distributions (one being Laurasian and the other Sub-Boreal European-Gondwanan) and feeding strategies. In addition, there was a significant divergence in ecomorphological characters between these subclades. While the Sub-

Boreal subclade attained larger body-sizes (≥ 5 m) and evolved durophagy, the Laurasian subclade was more phenotypically plastic (including an east-Asian freshwater clade, a near-pelagic clade, and a heavily armoured clade). Based on my first-hand comparative anatomical and phylogenetic results, I propose major taxonomic revisions to Teleosauroidea, including: (1) redefining Teleosauridae and introducing Machimosauridae; (2) the resurrection of several historical genera; (3) erecting seven new genera; and (4) referring to the infamous genus '*Steneosaurus*' as a *nomen dubium*. With this improved teleosauroid phylogenetic framework and updated alpha taxonomy (which allows thorough examination of their anatomical and ecological diversity), a new window has been opened on our understanding of these historically important crocodylomorphs.

LAY SUMMARY

Living crocodylomorphs (alligators, crocodiles and gavials) are one of the world's most fascinating and striking creatures, in part due to their unique anatomy, physiology, ecology and behaviour. While the generalized 'crocodile body plan' (e.g. sprawling limbs, large body sizes) is relatively well recognized, fossil crocodylomorphs were much more diverse in terms of their overall appearance. One of these extreme examples are the thalattosuchians, in which some derived species evolved whale-like or dolphin-like body forms. Within thalattosuchians, there are two main groups: the well-known metriorhynchids ('dolphin-like' with a tail fin, tail flukes and no body armour) and lesser-known teleosauroids ('gavial-like' with elongated snouts and extended dorsal armour). Due to a confusing history, teleosauroid evolutionary relationships are poorly understood, which hinders additional studies such as examining their ecology, feeding or distributional patterns.

The focus of this project is to examine teleosauroid evolutionary relationships and designate a new taxonomy (or classification) for the entirety

of the group. Hundreds of teleosauroid specimens from around the world will be examined and plotted into a spreadsheet (the most comprehensive to date), which will then produce a phylogenetic (evolutionary) tree using two specific software programs. With these in-depth phylogenetic results, teleosauroid evolutionary trends (such as species richness, distribution and ecomorphology) can be studied through time. This phylogenetic framework is essential for examining the biology of fossil organisms, which in turn can be used in comparison with modern day animals, influencing zoological, ecological and conservation studies.

Abstract

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INSTITUTIONAL ABBREVIATIONS

AMNH American Museum of Natural History, New York, United States of America

BHN2R Muséum d'Histoire Naturelle de Boulogne-sur-Mer, France (closed in 2003)

BIRUG Lapworth Museum of Geology, Birmingham, United Kingdom

BRLSI Bath Royal Literary and Scientific Institution, Bath, United Kingdom

BSY Catalogue du patrimoine paléontologique jurassien – A16, Porrentruy, Switzerland

CAMSM Sedgwick Museum of Earth Science, Cambridge, United Kingdom

DFMMh Dinosaurier-Freilichtmuseum Münchehagen, Lower Saxony, Germany

DONMG Doncaster Museum, Doncaster, United Kingdom

DORCM Dorset County Museum, Dorchester, England, United Kingdom

FMNH Field Museum of Natural History, Chicago, United States of America

GPIT Paläontologische Sammlung der Eberhard Karls Universität, Tübingen, Germany

GrozNII Grozny Petroleum Research Institute, Chechen Republic, Russia

GZG Geologisches institut Geologisch-Paläontologisches, Göttingen, Germany

HLMD Hessisches Landesmuseum, Darmstadt, Germany

Institutions

IRSNB Institut Royal des Sciences Naturelles de Bruxelles, Brussels, Belgium

IVPP Institute of Paleontology and Paleoanthropology, Beijing, China

LMH Landesmuseum, Hannover, Germany

LPP Institut de paléoprimatologie, paléontologie, humaine évolution et paléoenvironnements Université de Poitiers, Poitiers, France

LWL Museum für Naturkunde, Münster, Germany

MANCH Manchester Museum, Manchester, United Kingdom

MCNV Museo de Ciencias Naturales de Valencia, Valencia, Spain

MG Museu Geológico, Lisbon, Portugal

MGP-PD Museo di Geologia e Paleontologia dell'Università di Padova, Padova, Italy

MHNB Musée d'Histoire Naturelle, Boulogne-sur-mer (closed in 2003)

MHNM Muséum d'Histoire Naturelle de Marrakech, Marrakech, Morocco

ML Museu da Lourinhã, Lourinhã, Portugal

MMG Staaliches Museum für Mineralogie und Geologie, Dresden, Germany

MNHN Muséum National d'Histoire Naturelle, Paris, France

MNHNL Musée National d'Histoire naturelle, Luxembourg City, Luxembourg

MUHNAC Museu Nacional de História Natural e da Ciência Lisbon, Lisbon, Portugal

Institutions

MPV Musée paléontologique (Paléospace) de Villers-sur-Mer, Normandy, France

NHMUK Natural History Museum, London, United Kingdom

NHMW Naturhistorisches Museum Wien, Vienna, Austria

NM Národní museum, Prague, Czech Republic

NMBE Naturhistorisches Museum Bern, Switzerland

NMBS Naturhistoriches Museum Basel, Switzerland

NMR Naturkundemuseum Reutlingen, Reutlingen, Germany

NMNSJ National Museum of Nature and Science, Tokyo, Japan

NMS Naturmuseum Solothurn, Switzerland

NMSc Natural Museum of Scotland, Edinburgh, United Kingdom

NMW National Museum Wales, Cardiff, United Kingdom

NOTNH Nottingham Natural History Museum, Nottingham, United Kingdom

NZM-PZ Naturhistoriska Riksmuseet Palaeozoological, Stockholm, Sweden

ONM Office National des Mines, Tunis, Tunisia

OUMNH Oxford University Museum of Natural History, Oxford, United Kingdom

PETMG Peterborough Museum and Art Gallery, Peterborough, United Kingdom

PIN Paleontological Institute, Moscow, Russia

PMU Evolutionsmuseet Uppsala Universitet, Uppsala, Sweden

Institutions

PRC Palaeontological Research and Education Centre, Maha Sarakham University, Thailand

ROM Royal Ontario Museum, Toronto, Canada

SBU Stony Brook University, New York, United States of America

SCR Catalogue du patrimoine paléontologique jurassien – A16, Porrentruy, Switzerland

SMF Naturmuseum Senckenberg Frankfurt, Germany

SMHM Staaliches Naturhistorisches Museum, Braunschweig, Germany

SMNS Staatliches Museum für Naturkunde Stuttgart, Baden-Württemberg, Germany

TCH Catalogue du patrimoine paléontologique jurassien – A16, Porrentruy, Switzerland

UoE University of Edinburgh, Edinburgh, United Kingdom

USNM PAL Smithsonian National Museum of Natural History, Paleobiology Collections

YORYM Yorkshire Museum, York, United Kingdom

CHAPTER I:

The Historical Background of Teleosauroidea, one of the Oldest Known Fossil Crocodylomorph Groups

"Taxonomy is described sometimes as a science and sometimes as an art, but really it's a battleground."

- Bill Bryson

PREFACE: I was responsible for all the work carried out in this chapter, including the background and historical reading, as well as figures.

INTRODUCTION

In 1758, Capt. William Chapman, an English engineer, wrote a scientific letter to Mr. John Fothergill in the Philosophical Transactions of the Royal Society of London, briefly describing and illustrating a large partial skull of an "…animal amongst those of the lizard kind: by the length […] it seems to have been an allegator [alligator]…" (Chapman 1758: 691). This specimen (NHMUK PV R 1088) (Fig. 1), now housed in collections at the Natural History Museum (NHMUK) in London, England, was one of the first thalattosuchians ever to be described in a scientific journal.

Figure 1. '*Steneosaurus chapmani*' Buckland 1836 (now classified as '*Steneosaurus*' *bollensis* von Jäeger 1828) (NHMUK PV R 1088) from the Toarcian of Whitby, UK. Chapman's original 1758 discovery, which he considered an alligator.

Thalattosuchia represent an extraordinary group of Jurassic crocodylomorphs (an inclusive archosaur clade that includes all extant crocodilians and their fossil relatives) that flourished along coastlines and beneath the waves from approximately 189 to 127 million years ago (mya), and are divided into two main clades (Fig. 2). The first is Metriorhynchoidea (Fig. 2A); these animals are particularly well known, partially due to their

extraordinary transition into a purely pelagic environment resulting in their unique anatomy, including a hypocercal tail, lack of osteoderms, and paddle-like limbs. They have been extensively studied in the past two decades in terms of morphology (e.g. Frey et al., 2002; Young et al., 2012; Chiarenza et al., 2015; Wilberg, 2015b; Foffa et al., 2018c), internal anatomy (e.g. Fernández & Herrera, 2009; Fernández et al., 2011; Herrera et al., 2013, 2018), phylogeny (e.g. Pol & Gasparini, 2009; Young et al., 2010; Wilberg, 2015b; Ősi et al., 2018) and ecology (e.g. Pierce et al., 2009a; Young et al., 2011a, 2011b; Foffa et al., 2018a). The second thalattosuchian clade, in which Chapman's 1758 specimen belongs to, is Teleosauroidea (Fig. 2B).

Figure 2. Representatives of Thalattosuchia: (A) Metriorhynchoidea (*Metriorhynchus*; GPIT-RE-119314) and (B) Teleosauroidea ('*Steneosaurus*' *bollensis* von Jäeger 1828; GPIT-RE-

9427). Scale bar (B): 100 mm; (A) not to scale.

Teleosauroids represented a diverse and successful group of extinct crocodylomorphs that were abundant during the Mesozoic Era. The majority of these animals frequented shallow marine and brackish ecosystems

throughout the Jurassic (Buffetaut et al., 1981; Buffetaut 1982; Vignaud, 1993; Hua & Buffetaut, 1997; Hua 1999; Foffa et al. 2015; Johnson et al. 2015, 2017, 2018), although certain taxa have also been found in freshwater (Young, 1948; Li, 1993; Martin et al., 2016, 2019) and deep-water (Hulke, 1877; Foffa et al., 2019) deposits. Teleosauroids attained near-global distribution, with representatives being found throughout the UK and Europe (Eudes-Deslongchamps, 1867-69; Westphal, 1961, 1962; Andrews, 1909, 1913; Benton & Taylor, 1984; Young et al., 2014a; Johnson et al., 2017; Čerňanský et al., 2017; Foffa et al., 2019) as well as in Africa (Newton, 1893; De Lapparent, 1955; Buffetaut et al., 1981; Bardet & Hua, 1996; Fara et al., 2002; Fanti et al., 2016; Jouve et al., 2016; Dridi & Johnson, in press), Asia (Young, 1948; Liu, 1961; Li, 1993; Martin et al., 2019), India (Owen, 1852; Phansalkar et al., 1994), Siberia (Efimov 1982, 1988; Storrs & Efimov, 2000), Colombia (Cortes et al., in press) and potentially North America (possibly represented by USNM PAL 357211 to 357215). They have often been regarded as marine analogues of extant gavials (*Gavialis gangeticus* (Gmelin, 1789)), as many species possessed an elongate and tubular snout, dorsally directed orbits and a high tooth count, which was suggestive of a piscivorous feeding style and catching small, fast-moving prey (Andrews 1909, 1913; Buffetaut 1982; Hua 1999; Young et al. 2014a).

During the past 10 to 15 years, an increasing number of studies have begun to explore teleosauroid anatomy in greater depth (e.g. Jouve, 2009; Martin & Vincent, 2013; Young & Steel, 2014; Young et al., 2014a, b; Foffa et al., 2015, 2019; Johnson et al., 2015, 2017, 2019; Young et al., 2015; Fanti et al., 2016; Martin et al., 2019; Sachs et al., 2019b). These studies have begun to change the historical perspective of teleosauroids, in which these crocodylomorphs were initially considered postcranially conservative, with only the skull being studied in detail (e.g. Andrews, 1913). In addition, there have also been limited publications on teleosauroid mechanics (Pierce et al., 2009a, 2009b), neuroanatomy (Brusatte et al., 2016), and body size and ecology (e.g. Young et al., 2016; Foffa et al., 2018a, 2019). However, the interrelationships within Teleosauroidea are still poorly understood and little studied, and an in-depth, comprehensive investigation into their phylogenetics has yet to be accomplished. One contributing problem is the

concept of *Steneosaurus*, the most commonly used teleosauroid genus. The validity of *Steneosaurus* has recently been a topic of debate, with one main question overshadowing others: what exactly is *Steneosaurus* (what does it pertain to)? The type specimen, located in the Muséum National d'Histoire Naturelle (MNHN) in Paris, France, has rarely been referenced or figured in the literature since the early 1800s, adding to the current taxonomic confusion.

This chapter offers a concise historical background of Teleosauroidea focusing on key discoveries, important figures that contributed to teleosauroid research and major memoirs that include respectable amounts of information on these little understood crocodylomorphs.

HISTORICAL BACKGROUND

1.1 *The first official teleosauroids (the late 18th and early 19th Centuries)*

As mentioned previously, the first teleosauroid specimen was officially described in a scientific journal in 1758 (Chapman, 1758), with initial thought that the bones belong to a giant alligator (Fig. 3). After its discovery, it was given the name '*Steneosaurus chapmani*' by Buckland (1836), but it is now thought to belong to '*Steneosaurus*' bollensis von Jäeger 1828. This specimen (NHMUK PV R 1088), from the early Jurassic of Whitby, UK, consists of a partial skeleton, including a nearly complete skull. Chapman (1758: 688) describes it as coming from "…what we call allum-rock; a kind of black slate, that may be taken up in flakes, and is continually wearing away by the surf of the sea…". The fossil was sent to J. Fothergill, who eventually presented it to the Royal Society (when the fossil was sent and presented is unknown). Interestingly, Morton & Wooller (1758) also briefly described this specimen, stating "…this [skeleton] will most probably appear to have belonged to an animal of the lizard kind, quadruped and amphibious; and as to its size, much larger than anything of that kind ever met with or found in this part of the world…" (Morton & Wooller, 1758: 787) and comparing the cranium to that of fishes.

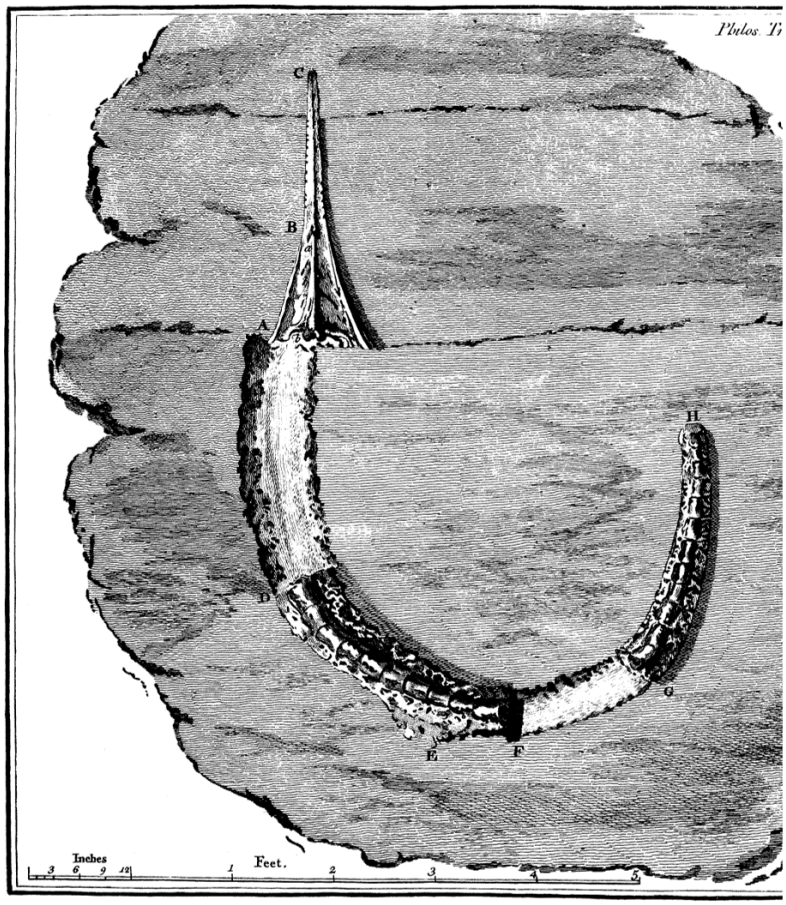


Figure 3. Original drawing of NHMUK PV R 1088 from Chapman's (1758) description. Taken from Chapman (1758).

The first teleosauroid to be scientifically named was *Crocodilus priscus* (NHMUK PV R 1086) by von Sömmering in 1814. Geoffroy Saint-Hilaire (1831:48) also noted this species for its unique appearance, stating that: "*…je soupçonne que le* Crocodilus priscus *ou le gavial de Soemmering, bien qu'il appartienne par les conditions d'organisation les plus générales au type téléosaurien, n'est toutefois, ni un vrai téléosaurus ni un sténéosaurus: il renfermerait ainsi les éléments d'un nouveau genre à former…*" ("…I suspect that the *Crocodilus priscus* or the gharial of Soemmering, although it belongs by the conditions of organization [to] the most general teleosaurian type, however, is not, nor a true *Teleosaurus* nor a *Steneosaurus*: it would contain so the elements of a new kind to describe…"). This specimen would later be classified as the genus *Aeolodon* by von Meyer in 1832. In November 1817, the first specimen of *Teleosaurus* (*Crocodilus*) *cadomensis* was discovered in a quarry near the town of Germany (renamed Fleury-sur-Orne in 1916) (Lamouroux, 1820; Brignon, 2013). The quarry was full of 'Caen stone', a

Bathonian-age limestone. Various researchers, including François Luard, Jacques Amand Eudes-Deslongchamps and M.M. Tesson, acquired multiple blocks from this site, each containing different parts of this particular specimen. Tesson, a friend of J. A. Eudes-Deslongchamps who possessed an impressive collection of Jurassic fossils from Normandy, eventually gave his section of this material to Jean-Vincent Félix Lamouroux (when is unknown), who named the specimen *Crocodilus cadomensis* (Lamouroux, 1820) before sending it to Georges Cuvier. Cuvier (1824) then properly described and figured *T. cadomensis*, and Geoffroy Saint-Hilaire (1825) based his diagnosis of the genus *Teleosaurus* of this specimen. Along with '*C.*' *priscus* and *Teleosaurus*, an additional partial skull representing another teleosauroid (Cornbrash Formation of Gibraltar, near Oxford) was briefly mentioned by De la Bêche & Conybeare (1821). This skull was fleetingly noted again by Conybeare & Phillips (1822) and then was surprisingly neglected for a long period. This skull (OUMNH J.1401) represents one of the most confusing specimens in teleosauroid taxonomy, as it was initially not named nor figured by De la Bêche & Conybeare (1821) (see Chapter III for more details).

However, despite the inarguably important discoveries and descriptions of the aforementioned teleosauroid taxa, probably the most significant (and befuddling) teleosauroid specimen found during the late 18th and early 19th Centuries was MNHN.RJN 134c-d, known as *Steneosaurus rostromajor* and the foundation for the genus *Steneosaurus*. The actual discovery of this specimen has been shrouded in mystery; but it is now credited to one significant, and often overlooked, figure that contributed much to the study of French palaeontology. This character is Father Charles Bacheley (1716-1795), a priest from Normandy that developed a keen interest in geology and palaeontology (Brignon, 2016). Bacheley collected hundreds of rocks and fossils from Normandy and Sainte Catherine, with some of his most notable findings coming from near the Vaches Noires cliffs. Fossils had already been reported from these cliffs by Antoine de Jussieu in 1722 (Jussieu, 1724), Pedro Franco Davila in 1767 (Brignon, 2014c) and Father Jacques-François Dicquemare in 1776 (Buffetaut, 1983; Taquet, 1994); Bacheley (1778a, 1778b) had also written transcripts on the abundant

Vaches Noires fossils, noting that they had been found throughout the cliffs as well as along the shoreline. Importantly, therein Bacheley briefly described remains of marine crocodilians that were eventually studied by Cuvier (1808, 1824), adding that he believed these bones belonged to cetaceans (namely sperm whales or dolphins) (Brignon, 2016). Despite Carl Linnaeus (1758) classifying cetaceans as mammals, the popular belief that they were fishes lingered throughout the 18th Century, implying that Bacheley (and others) considered these fossils as fishes when referring to them as cetaceans (Dicquemare, 1776; Montribloud, 1782; Romé de l'Isle & Davila, 1767; Varenne de Béost, 1774; Brignon, 2014c, 2016). Bacheley continued to add to his collection of fossils throughout his life, and after his death, the École Centrale de Rouen acquired his collection (Fouray, 1978; Brignon, 2016). Louis-Benoît Guersent, a professor of natural history at the school, informed Georges Cuvier of the Vaches Noires fossils and, with the permission of Jacques Claude Beugnot (the prefect of the department of Seine-Inférieure), they were sent to Cuvier (Brignon, 2016).

***1.2** Georges Cuvier, Étienne Geoffroy Saint-Hilaire and Christian Erich Hermann von Meyer, and their contributions to the study of teleosauroids*

The first truly in-depth teleosauroid descriptions must be credited to Georges Cuvier (1769-1832) (Fig. 4A), an immensely famous French naturalist and zoologist, who contributed countless works to the study of palaeontology. When he received the agreed selection of Father Bacheley's collection, Cuvier (1800) briefly noted the existence of Bacheley's Vaches Noires 'gavials du Honfleur'; in 1808 and 1812, he expanded his notes into more detailed descriptions along with figures (Fig. 5). Cuvier (1808, 1812) wrote that pieces of the first 'gavial du Honfleur', a partial skull and rostrum (which is a chimera of metriorhynchid and teleosauroid material, respectively), came from Messieurs Besson, Faujas de Saint-Fond, de Drée and Jurine, although it appears that all pieces were originally from the Bacheley collection (Brignon, 2016). Cuvier (1808, 1812) briefly compared the rostrum and skull to that of the gavial, stating similar and different characteristics (see Chapter VI for more information). In 1824, Cuvier wrote an extensive study on crocodilian osteology, both fossil and modern, in his famed *Ossemens*

Fossiles V Partie, (note that throughout the thesis, 'crocodilian' refers specifically to a member of the Crocodylia, including alligators, crocodiles and gavials) and included the 'gavials du Honfleur' in his descriptions. Cuvier (1824) labelled the rostrum/skull specimen as "*téte à museau plus allongé*" (skull with elongated snout), and provided a more in-depth comparison with the modern gavial (*Gavialis*). Cuvier (1824) also described a new specimen from Geneva that he called "*téte à museau plus court*" (skull with shortened snout), mentioning that it differed from the gavial and "*téte à museau plus allongé*" specimen by the length of the rostrum (this specimen was later revealed to be a metriorhynchid).

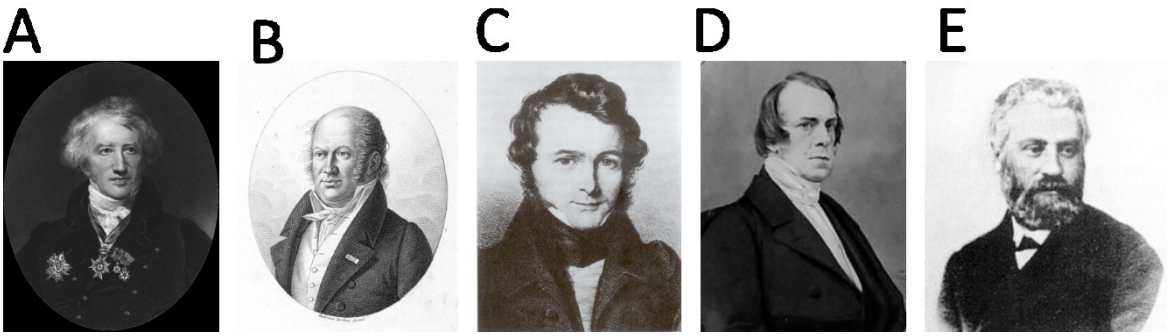


Figure 4. Prominent historical figures that contributed important works to the study of teleosauroids: (A) Georges Cuvier (1769-1832); (B) Étienne Geoffroy Saint-Hilaire (1772-1844); (C) Christian Erich Hermann von Meyer (1801-1869); (D) Heinrich Georg Bronn (1800-1862); and (E) Eugène Eudes-Deslongchamps (1830-1889). Photos from Wikipedia.

Another well-known French naturalist, Étienne Geoffroy Saint-Hilaire (1772-1844) (Fig. 4B), classified Cuvier's "*téte à museau plus allongé et court*" (elongated and shortened snout) specimens as *Steneosaurus rostromajor* ("*téte à museau plus allongé*" specimen) and *Steneosaurus rostrominor* ("*téte à museau plus court*" specimen), and used them as the foundation to establish the new teleosauroid genus *Steneosaurus* (Geoffroy Saint-Hilaire, 1825). Geoffroy Saint-Hilaire (1831) also provided in-depth descriptions of Teleosauridae (or Thalattosuchia) as well as comprehensive comparisons between the genera *Teleosaurus* and *Steneosaurus*.

In addition to the creation of the genera *Steneosaurus* and *Teleosaurus*, the genus *Machimosaurus* was established in 1837 by Christian Erich Hermann von Meyer (1801-1869) (Fig. 4C), a German

palaeontologist, using the binomial name *Machimosaurus hugii*. Awkwardly, the name was initially misspelt as *Madrimosaurus hugii* (von Meyer, 1837: 560); von Meyer attributed this to "*Die Undeutlichkeit meiner Handschrift*" ("the indistinctness of my handwriting") (von Meyer, 1838: 415), and the spelling was then corrected (von Meyer, 1838). Interestingly, *Machimosaurus* teeth had been published before von Meyer's 1837 classification; Cuvier figured one tooth in 1824, and Römer figured another in 1836 (although he attributed it to *Ichthyosaurus*). In addition to his work on *Machimosaurus*, von Meyer (1845) also established the genus *Sericodon* when examining multiple teeth from Switzerland and Germany.

Two additional German researchers that examined key teleosauroid fossils were Heinrich Georg Bronn (1800-1862) (Fig. 4D) and Johann Jakob Kaup (1803-1973). Bronn (1835-1837, 1841) established the genera *Leptocranius* (based off Geoffroy Saint-Hilaire's [1825] *S. rostromajor*, and which was eventually merged into *Steneosaurus*) and *Pelagosaurus* (a basal metriorhynchoid historically believed to be a teleosauroid). In contrast, Kaup (1834) created the genus *Mystriosaurus* (based off a partial skull discovered in Altdorf by Johann Friedrich Bauder, a merchant and naturalist; Sachs et al., 2019b), providing a more detailed description with diagnostic characters in 1837. Kaup (1837; in Bronn & Kaup, 1841) later referred several specimens from both Germany and England as *Mystriosaurus* and established multiple new species (Sachs et al., 2019b).

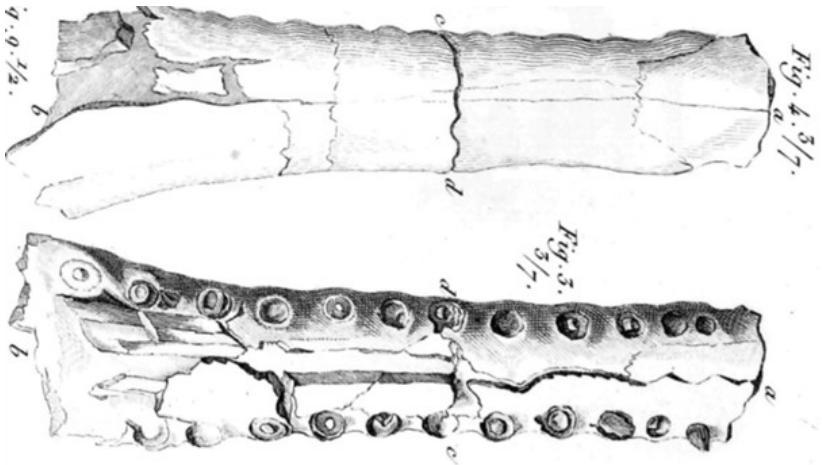


Figure 5. Drawing of Cuvier's "*téte à museau plus allongé*" (skull with elongated snout) specimen (MNHN.RJN 134c-d). Taken from Cuvier (1812: pl II, fig. 3-4).

***1.3** Jacques Amand and Eugène Eudes-Deslongchamps, and* 'Notes Paleontologiques'

During the latter half of the 19th Century, French father-and-son dynamic Jacques Amand (1794–1867) and Eugène Eudes-Deslongchamps (1830-1889) (Fig. 4E) contributed countless works to the study of zoology, palaeontology and natural history. Following in the footsteps of Cuvier (1824) and Geoffroy Saint-Hilaire (1825, 1831), they provided detailed, in-depth descriptions and comparisons of multiple teleosauroids, and scientifically named many important and recognized species, including: '*Steneosaurus*' *megistorhynchus* Eudes-Deslongchamps, 1866a; '*Steneosaurus*' (*Yvridiosuchus*) *boutilieri* Eudes-Deslongchamps, 1868c; '*Steneosaurus*' (*Deslongchampsina*) *larteti* Eudes-Deslongchamps, 1866a; and '*Steneosaurus*' *edwardsi* Eudes-Deslongchamps, 1868a. Both Eudes-Deslongchamps were also exceptionally critical of previous researchers (particularly Bronn, Kaup and Wagner) for attempting to compare other teleosauroid specimens with Cuvier's "*téte à museau plus allongé*" (skull with elongated snout) specimen (Eudes-Deslongchamps, 1867-69: 107, 112-114). The younger Eudes-Deslongchamps (1867-69: 107) writes "*Nos plus grands paléontologistes n'ont pas été à l'abri de ces erreurs; mais ce sont surtout les auteurs allemands qui ont tranché avec le plus de légèreté au milieu de ce magni fique ensemble dont le travail de mon père aura, je pense, et pour toujours, fixé les divisions et fait cesser les incertitudes*" ("Our greatest palaeontologists have not been immune [to] these errors; but it is especially the German authors who have decided most lightly in the midst of this magnificent ensemble, the work of which my father will have, I think, [and] forever fixed the divisions and put an end to the uncertainties"), and offers an explanation for his and his father's beliefs: "*Mon père et moi, nous avons eu l'avantage inappréciable de pouvoir juger d'après les pièces mêmes qui ont servi à Cuvier, à Geolïroy Saint-Hilaire et à de Blainville, tandis que les autres auteurs n'avaient pu se guider que par des figures souvent inexactes et des restaurations tout-à-faît hasardées*" ("My father and I had the inestimable advantage of being able to judge from the very pieces that had

been used by Cuvier, by Geoffroy Saint-Hilaire, and de Blainville, while the other authors could only be guided by often inaccurate figures and restorations"). They were also sceptical of the validity of Kaup's *Mystriosaurus* (Eudes-Deslongchamps, 1867-69; Westphal 1961, 1962; Steel 1973; Sachs et al., 2019b), with E. Eudes-Deslongchamps (1867-69: 108) writing "*…ni mon père ni moi n'avons pu avoir encore d'opinion définitive sur le genre* Mystriosaurus*, ni savoir s'il doit être conservé, ou rayé de la nomenclature*" ("…neither my father nor I have yet been able to have a definitive opinion of the genus *Mystriosaurus*, nor to know whether it should be kept or deleted from the nomenclature").

Eugène Eudes-Deslongchamps wrote the massive volume *Notes Paleontologiques*, which spanned his and his father's work on fossil organisms from 1867 to 1869. Included were descriptions and figures of the teleosauroid taxa *T. cadomensis* (Fig. 6A), *T. geoffroyi*, *T. gladius* (both synonymous with *T. cadomensis*), '*S*.' *megistorhynchus*, '*S*.' *edwardsi*, '*S*.' *larteti* and '*S*.' *boutilieri* as well as the currently invalid species '*S*'. *oplites* (vertebrae and osteoderms), '*S*.' *atelestatus* (poorly preserved vertebrae), '*S*.' *roissyi* (lower jaw fragments: MNHN.RJN 130a-c) and '*S*.' *blumembachi* (rostral fragment). In a later publication, Eudes-Deslongchamps (1877) listed *Mystriosaurus*, *Teleosaurus*, '*Steneosaurus*', *Spatocranius*, *Aeolodon*, *Teleidosaurus*, *Metriorhynchus* and *Pelagosaurus* as valid teleosauroid genera. During the 19th Century, in addition to extended research, teleosauroids were often featured in scientific artwork (Fig. 6B-C), and were even featured in Crystal Palace Park in London (Fig. 6D).

1.4 *The early 20th Century, Charles W. Andrews and present day work*

During the late 1800s, further teleosauroid species were named following the massive work of the Eudes-Deslongchamps'; these included '*Steneosaurus*' *megarhinus* Hulke, 1871, from Britain; '*Steneosaurus*' *bouchardi* Sauvage, 1872, from France; '*Steneosaurus*' *brevior* Blake, 1876, from Britain (who briefly considered it as belonging to *T. chapmani*; Vignaud, 1995); '*Steneosaurus*' *heberti* Morel de Glasville, 1876, from France; '*Steneosaurus*' *stephani* Hulke, 1877, from Britain; *Machimosaurus mosae* Sauvage & Liénard, 1879, from France; and '*Steneosaurus*' *baroni* Newton, 1893, from

Madagascar. In 1871, Phillips erected a new species of *Teleosaurus*, *T. sublidens*, based on two lower jaw fragments but did not designate a type specimen. Lydekker (1888) elected the lectotype as one specimen figured by Phillips (1871, fig, 55). However, more recent work by Powell (2005) and Jouve (2009) have recognized *T. sublidens* to be a junior synonym of *T. cadomensis* (e.g. briefly discussed in Buffetaut & Jeffery (2012)), which is widely accepted.

Yet, the next major memoir involving teleosauroids was that of Charles William Andrews (1866-1924), a British vertebrate palaeontologist who worked in the British Museum in London. In 1909, Andrews briefly defined three new species, '*Steneosaurus*' *leedsi*, '*Steneosaurus*' *durobrivensis* (which is now found to be a junior synonym of '*S.*' *edwardsi*; see Johnson et al., 2015) and '*Steneosaurus*' (*Lemmysuchus*) *obtusidens* when examining the Alfred Nicholson Leeds Fossil Collection (Peterborough Member, Oxford Clay Formation (OCF), Middle Callovian) at the British Museum of Natural History (now the Natural History Museum of London, UK). His following 1913 book '*A Descriptive Catalogue of the Marine Reptiles of the Oxford Clay Part II*' presented in-depth, comparative descriptions of all teleosauroid species found from the OCF in Britain. These included '*S.*' *leedsi*, '*S.*' *durobrivensis*, '*S.*' *obtusidens* as well as a new species ('*S.*' *hulkei*) and genus (*Mycterosuchus*). However, Andrews (1909, 1913) based his own referral of *Steneosaurus* off '*S.*' *leedsi* due to "a nearly complete and comparatively uncrushed skull [of '*Steneosaurus*' *leedsi* (R.3806)] found in association with a nearly perfect skeleton" (Andrews, 1913: 82). He also limited his comparisons to that of skulls, stating that the postcranial material of teleosauroids were so similar that "special description is unnecessary" (Andrews, 1913: 133). Interestingly, contra the cautionary belief of the Eudes-Deslongchamps', Andrews (1913: 81) was adamant that *Mystriosaurus* was a valid taxon but should only be "used for the Liassic forms."

In 1951, P. H. Phizackerely wrote a revision of teleosauroid specimens housed at the Oxford Museum of Natural History (OUMNH), in an attempt to rectify taxonomic issues within the clade. Phizackerely (1951) provided brief

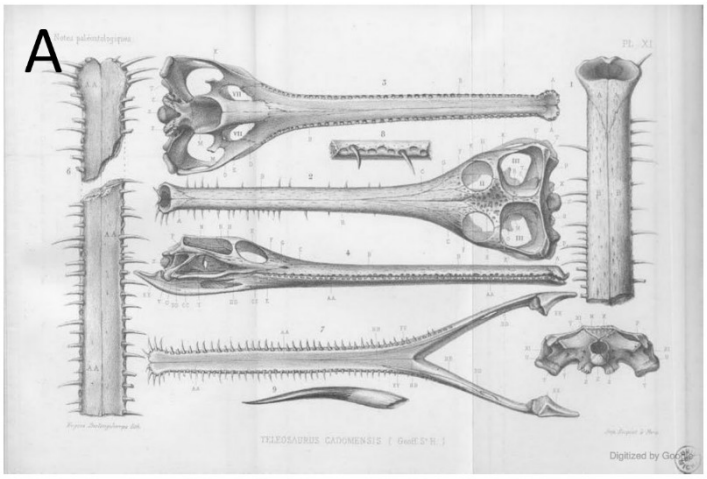
notes on *T. cadomensis*, '*S*.' *megistorhynchus*, '*S*.' *boutilieri*, '*S*.' *larteti*, '*Steneosaurus*' *meretrix* nov sp. (see Chapter III) and '*Steneosaurus*' *depressus* nov. sp. (see Chapter IV), but his descriptions were awkward and often inconsistent. In contrast, two of the most substantial and thorough works during the latter 20th Century was that of Frank Westphal in 1961 and 1962. Not only did he provide re-descriptions of '*S*.' *bollensis*, '*S*.' *brevior* and *Pelagosaurus*, but established the species '*Steneosaurus*' *gracilirostris* Westphal, 1961, and genus *Platysuchus* Westphal, 1961 (which had previously been classified as *Mystriosaurus* by Berckhemer in 1929). Another aspect of Westphal's (1961, 1962) work was widely accepting *Mys. laurillardi* as a subjective junior synonym of '*S*.' *bollensis*. Through Westphal's work, information pertaining to the Toarcian teleosauroids (namely those found in Germany) was more concise and precise than it had been previously (e.g. von Jäeger, 1828; Berkhemer, 1929).

There was a slight lull in teleosauroid studies after Westphal's (1961, 1962) work; interest in this group was only recently revived during the late 1900s. Many of these new studies (e.g. Steel, 1973; Buffetaut & Thierry, 1977; Buffetaut, 1980b, 1981a, 1981b; Benton & Taylor, 1984; Benton & Clark, 1988; Steel, 1989) summarized thalattosuchians (as well as teleosauroids and metriorhynchoids) as a whole, highlighting characteristic features, semi-marine adaptations and distributional patterns. However, certain publications (e.g. Buffetaut; 1979; Buffetaut et al., 1981; Li, 1993; Godefroit, 1994; Phansalkar et al., 1994; Bardet & Hua, 1996; Bizzarini, 1996; Dalla Vecchia, 1997) introduced teleosauroid material from Belgium, Luxembourg, Italy, Ethiopia, Madagascar, China, India and North America (note that the North American material is now classified as *Zoneait nargorum* Wilberg, 2015b, and '*Steneosaurus*' *barettoni* (MGP-PD 26552) from Sasso di Asiago, Italy, is a metriorhynchid [Cau & Fanti, 2011]). These studies stressed the importance of teleosauroid adaptability but strategically avoiding their taxonomic inconsistencies by placing everything within *Steneosaurus*. By the end of the 20th Century, only four teleosauroid genera were considered valid: *Teleosaurus*, *Platysuchus*, *Steneosaurus* and *Machimosaurus* (Sachs et al., 2019b), and there was continued debate as to whether or not *Pelagosaurus* and *Peipehsuchus* belonged within this group.

However, since the start of the 21st Century, there has been an increase in teleosauroid studies focusing on both new and historical specimens, morphological differences and interrelationships (e.g. Efimov & Storrs, 2000; Fara et al., 2002; Jouve, 2009; Young et al., 2014a; Jouve et al., 2016; Schaefer et al., 2018; Foffa et al., 2015, 2019; Johnson et al., 2017, 2019; Sachs et al., 2019b; Young & Steel, in press). In particular, the inconsistency of '*Steneosaurus*' is starting to be addressed, with new genera (e.g. *Yvridiosuchus*, *Bathysuchus* and *Deslongchampsina*) which were previously referred to '*Steneosaurus*' being established (Foffa et al., 2019; Johnson et al., 2019). Similar actions have been taken with *Machimosaurus*; Young et al. (2014a) recently split this genus into four distinct species: *Mac. hugii*, *Mac. mosae*, *Machimosaurus buffetauti* (officially designated a new species in Young et al. [2015]) and *Machimosaurus nowackianus* von Huene, 1938 (however, this decision is not without debate, as Martin et al. [2015] rebutted this finding). A fifth new species, *Machimosaurus rex* Fanti et al., 2016, was recently described, raising new questions about teleosauroid biogeography and time of extinction (*Mac. rex* is defined as coming from Hauterivian-Barremian deposits). This slow untangling of teleosauroid taxonomy has allowed for additional studies into internal anatomy (Brusatte et al., 2016), body size (Young et al., 2016), feeding and ecology (Young et al., 2015a; Foffa et al., 2018a; Martin et al., 2019), instances of convergence (Ballell et al., 2019) and morphometric analyses (Pierce et al., 2009a, 2009b) to begin exploring the biology and ecology of these crocodylomorphs.

In addition, select aspects of uncertain historical French palaeontological endeavours are slowly becoming unravelled (Brignon, 2013, 2014a, 2014b, 2014c, 2016). For example, Brignon (2013) reported that Geoffroy Saint-Hilaire originally planned to describe three new teleosauroid species in 1831: *Teleosaurus microtrèmes*, represented by vertebrae and dorsal osteoderms; '*Steneosaurus*' *aubignensis*, represented by jaws; and '*Steneosaurus*' *quillensis*, represented by the posterior skull and sections of postcranial material. These taxa were to be featured in a soon-to-be published descriptive tome, in collaboration with Jacques Amand Eudes-Deslongchamps, on the "*grands sauriens fossiles de Normandie*" (great fossil reptile of Normandy). Jean-Charles Werner (an artist specializing in natural

history and comparative anatomy, and affiliated with the museum in Paris), and François-Jacques Dequevauviller (a well-known artist who created several authors' portraits) illustrated the specimens for Geoffroy Saint-Hilaire (Brignon, 2013). However, this tome was never formally published, and the proposed species have been shown to correspond to other formally named taxa: '*Steneosaurus*' *aubignensis* with *Teleidosaurus calvadosii* Eudes-Deslongchamps, 1866b; '*Steneosaurus*' *quillensis* with '*Steneosaurus*' *megistorhynchus*; and *Teleosaurus microtrèmes* was to be the new proposed name to replace *T. cadomensis*. In addition, Brignon (2014a) reported that Geoffroy Saint-Hilaire had worked to prepare a book titled "*Histoire des crocodiliens renfermés dans le terrain oolithique*", which focused on thalattosuchian fossils from the Jurassic of Normandy, but this was never completed.



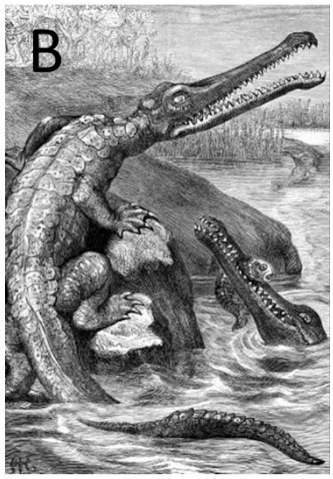


Figure 6. Additional historical teleosauroid illustrations: (A) *Teleosaurus cadomensis* (Eudes-Deslongchamps, 1867-69); (B) *Teleosaurus* by Edouard Riou (1880); (C) *British prehistoric marine reptiles by Paul D. Stewart* (1862); and (D) *Teleosaurus* statues featured in the Crystal Palace Park, London, UK.

CHAPTER II:

A Catalogue of Teleosauroids (Crocodylomorpha: Thalattosuchia) from the Toarcian and Bajocian (Jurassic) of southern Luxembourg

"The crocodile cannot turn its head. Like all science, it must always go forward with all-devouring jaws."

-Pyotr Kapitsa

PREFACE: This chapter was published as Johnson et al. (2018), and is a result of collaboration between myself, my supervisors Stephen Brusatte and Mark Young, and MNHNL curators Ben Thuy and Robert Weiss. The majority of this paper, including the descriptions, comparisons, figures and conclusions, was my original work. I visited the MNHNL to examine all the specimens included in the manuscript, took all the original photographs herein, and wrote and formatted the manuscript. Mark Young and Stephen Brusatte both provided thoughtful discussion, insight, and edited the manuscript thoroughly. Ben Thuy and Robert Weiss both assisted me at my visit to the MNHNL, provided extra information on the geological formations in Luxembourg, and edited the manuscript.

INTRODUCTION

Teleosauroid crocodylomorphs – distant extinct relatives of modern crocodiles – were a near-globally distributed clade that frequented shallow marine and brackish ecosystems throughout the Jurassic (Buffetaut, 1982; Hua, 1999; Foffa et al., 2015; Johnson et al., 2015; Martin et al., 2016; Johnson et al., 2017). Often they have been regarded as marine analogues of extant gavials, as most species had an elongate and tubular snout, high tooth count and dorsally directed orbits, suggesting a feeding style of catching small, fast-moving prey (Andrews, 1909, 1913; Buffetaut, 1982; Hua, 1999; Young et al., 2014a).

Teleosauroids were a key component of the marine reptile fauna in the Toarcian (Early Jurassic) of England and western Europe (Westphal, 1961, 1962; Benton & Taylor, 1984; Walkden et al., 1987; Mueller-Töwe, 2006). Hundreds of specimens have been recovered and researched from deposits in Germany (Jäger, 1828; Westphal, 1961, 1962) and Britain (Seeley, 1880; Westphal, 1961; Benton & Taylor, 1984; Williams et al., 2015; Brusatte et al., 2016). The most common Toarcian teleosauroids include *Steneosaurus bollensis* Jäger, 1828 (which is well represented by many specimens from

Germany and the UK), *Steneosaurus brevior* Blake, 1876, and *Steneosaurus gracilirostris* Westphal, 1961 (both of which are documented from the UK). Another taxon, albeit rarer, is present in the Toarcian of Germany, *Platysuchus multiscrobiculatus* (Berckhemer, 1929) Westphal, 1961.

Teleosauroid specimens have also been reported from Luxembourg, but only some of these have been mentioned in the literature, and few have been described in any detail (Godefroit, 1994). Here we present and describe several Toarcian (and one Bajocian) specimens from southern Luxembourg, many for the first time. We identify nine teleosauroids and five Thalattosuchia indeterminate, among which are specimens that can be assigned to two distinct teleosauroid genera (*Steneosaurus* and *Platysuchus*) and three, or possibly four, distinct species.

GEOLOGY

The Grand-Duchy of Luxembourg is situated between the countries of Germany, France, and Belgium (Fig. 1). While it is relatively small in size (roughly 2586 km^2 in area), it displays a wide range of geological strata (Weis & Mariotti, 2007; Schintgen & Förster, 2013), with predominately Paleozoic and Triassic outcrops in the North and East, and Jurassic outcrops in the central and southern areas. These Jurassic deposits, characterised by the Paris Basin margin type, are typically Lower to Middle Jurassic (Hettangian-Bajocian) in age (Lucius, 1948; Bintz et al., 1973; Weis & Mariotti, 2007). The deposits are widespread, and run through several southern communes (Fig. 1). Three lithological units are Toarcian in age and particularly fossiliferous (Godefroit, 1994; Guérin-Franiatte et al., 2010). These outcrops are normally composed of bituminous black shales with intercalated nodular limestone beds (Song et al., 2014; Hermoso et al., 2014; Nel & Weis, 2017). One of these units is present throughout southern Luxembourg, and can be assigned to the *Harpoceras serpentinum* ammonite Zone (Guérin-Franiatte et al., 2010). It is approximately 40-45 m thick and is contemporaneous with both the Posidonienschiefer Formation in Germany and the '*Schistes Carton*' in France (Hermoso et al., 2014; Ruebsam et al., 2014; Song et al., 2014).

Recently referred to as '*schistes bitumineux*', this zone is Lower Toarcian in age and contains a variety of invertebrate and vertebrate fossils, including cephalopods and marine reptiles, and insects (e.g. Godefroit, 1994; Henrotay et al., 1998; Delsate, 1999; Nel & Weis, 2017; Szwedo et al., 2017; Vincent et al., 2017).

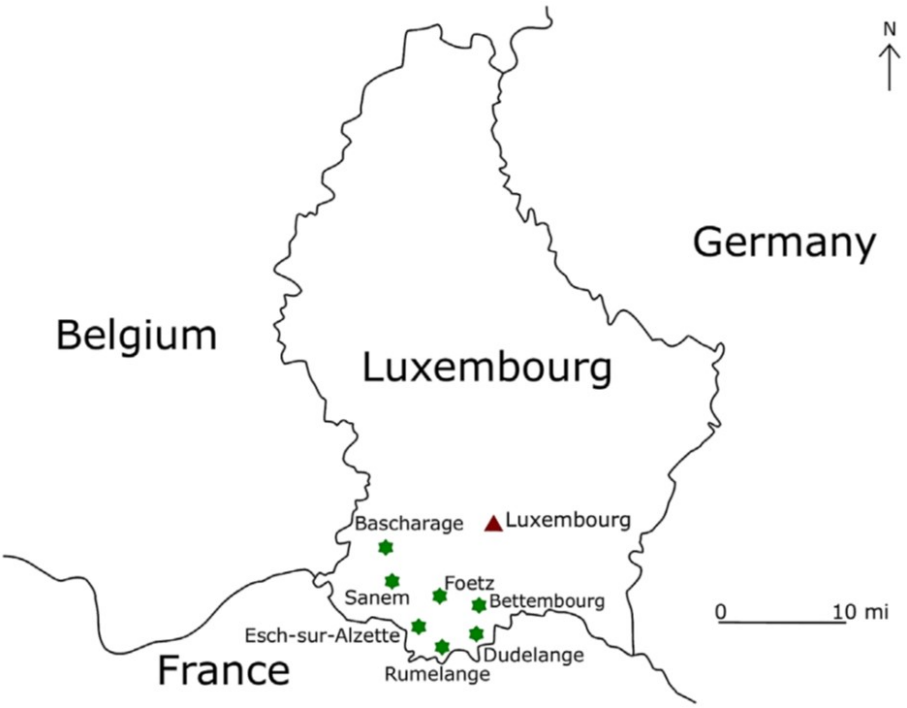


Figure 1. Map of Luxembourg. The red triangle indicates the capital, Luxembourg City, and the green stars indicate communes (areas) where teleosauroid specimens have been found: Bascharage, Sanem, Foetz (not a commune but rather a small town), Esch-sur-Alzette, Rumelange and Dudelange. Note that all communes are situated in the south of Luxembourg, and that all exact localities where specimens were found is unknown.

Institutions: IVPP, Institute of Paleontology and Paleoanthropology, Beijing; MMG, Staaliches Museum für Mineralogie und Geologie, Dresden; MNHN, Muséum national d'Histoire naturelle, Paris; MNHNL, Musée national d'histoire naturelle, Luxembourg; NHMUK, Natural History Museum, London, UK; OUMNH, Oxford University Museum of Natural History; SMNS, Staaliches Museum für Naturkunde, Stuttgart; YORYM, Yorkshire Museum, York, UK.

Anatomical: XII, cranial nerve 12; al, alveolus; am, ammonite impression; an, angular; ?ant o, possible area of antorbital fenestra; ar, articular; bao, basioccipital; ?bas, possible basisphenoid; bel, belemnite; cen, vertebral

centrum; cer r, cervical rib; corc, coracoid; cg, costal groove (dorsal rib); den, dentary; ectp, ectopterygoid; ex, exoccipital; fm, foramen magnum; fr, frontal; hum, humerus; if, incisive foramina; jug, jugal; k, keel of osteoderms; lac, lacrimal; ms, mandibular symphysis; mx, maxilla; na, nasal; ns, neural spine; oc, occipital condyle; or, orbit; os, osteoderm; pal, palatine; par, parietal; paroc, paroccipital process; pc, palatal canals (grooves); ?ph, possible phalanx; po, postorbital; prf, prefrontal; pt, pterygoid; q, quadrate; ?rad, possible radius; rap, retroarticular process; rec p, reception pits; rib h, rib head; spl, splenial; sq, squamosal; ste, sternal end; sup occ, supraoccipital; supr fen; supratemporal fenestra; san, surangular; t, tooth; tub, tuberculum; tp, transverse process; 1st mx al, first maxillary alveolus; 1st pmx al, first premaxillary alveolus; 2nd pmx al, second premaxillary alveolus; 3rd pmx al, third premaxillary alveolus; 5th pmx al, fifth premaxillary alveolus.

SYSTEMATIC PALAEONTOLOGY

CROCODYLOMORPHA Hay, 1930 (sensu Nesbitt 2011)

THALATTOSUCHIA Fraas, 1901 (sensu Young and Andrade 2009)

TELEOSAUROIDEA Geoffroy Saint-Hilaire, 1831 (sensu Young and Andrade 2009)

STENEOSAURUS cf. *BOLLENSIS* Jäger, 1828

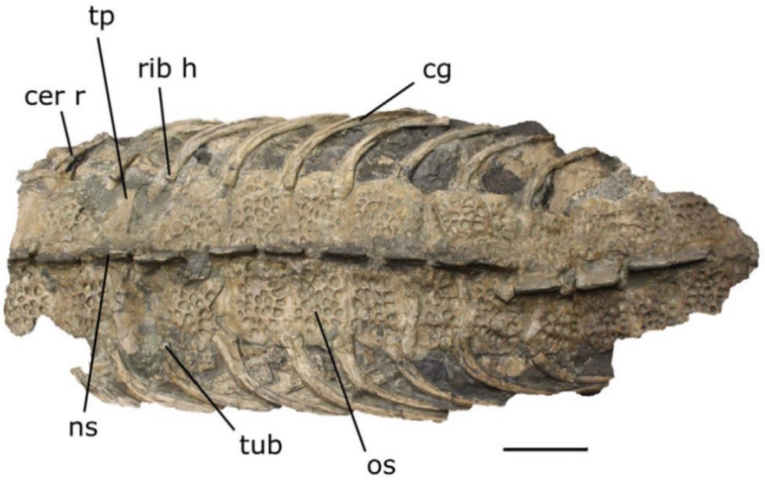


Figure 2. Photograph of *Steneosaurus* cf. *bollensis* (Jäger 1828), MNHNL TU155. Thoracic postcranial skeleton in dorsal view. Refer to the main text for the abbreviations list. Scale bar: 5 cm.

Material: a nearly complete thorax, including one cervical rib and 17 dorsal ribs, 13 dorsal vertebral neural spines and multiple osteoderms (MNHNL TU155).

Horizon and locality: *Harpoceras serpentinum* ammonite Zone ('*schistes bitumineux*'), Bascharage, Luxembourg; Early Toarcian, Early Jurassic.

Description: MNHNL TU155 is a well-preserved and nearly complete thoracic portion of a postcranial skeleton preserved in dorsal view (Fig. 2). The neural spines of thirteen dorsal vertebrae are preserved but the centra and the majority of the transverse processes are obscured by the paramedian osteoderms. One transverse process (on the right side of the third vertebra) is visible (Fig. 2). It is relatively mediolaterally short in length, anteroposteriorly broad and appears to have a rounded distal end. The neural spines are dorsoventrally short and anteroposteriorly elongated, with the edges slightly rounded. There is one partially complete cervical rib (the tuberculum and capitulum are missing) and it is T-shaped with a dorsomedially straight rim (Fig. 2). The dorsal ribs are dicephalous, narrow considerably distally to the rib head and are dorsoventrally thin. The tuberculum is well pronounced and rounded (Fig. 2). The costal groove (Fig. 2) is large and deep, and runs from the ventral edge of the tuberculum to near the sternal end. The sternal end of the ribs are straight, thin in width, and anteroposteriorly flat. The dorsal osteoderms (Fig. 2) are mediolaterally elongated and roughly arranged in parallel rows (one row per side). A small yet pronounced keel is present. The pits are large, roughly the same size as each other and irregularly shaped, and are situated relatively close to one another.

Discussion: The thorax initially comes from a carbonate nodule. During the 1990s, it was integrated into a 'Posidonia shale' slab from Holzmaden, Germany, for esthetical reasons, by the preparatory of the museum at that time, M. John Heil. The presence of well-developed paramedian osteoderms

immediately identifies MNHNL TU155 as a teleosauroid and not a metriorhynchoid (note that the basal metriorhynchoid *Pelagosaurus typus* Bronn, 1841 (Eudes-Deslongchamps, 1866; Delfino & Dal Sasso, 2006; Pierce & Benton, 2006; Pierce et al., 2017), does have dorsal osteoderms but these are generally smaller, thinner and less extensive when compared with teleosauroids, with the exception of *Aeolodon priscus* von Sömmerring, 1814. The pits in *P. typus* are also circular and closely packed together (MNHN.F RJN 463). There are thirteen preserved dorsal neural (vertebral) spines seen in MNHNL TU155 that are shortened with rounded edges; however, neural spines rarely differ in Toarcian teleosauroids (and Teleosauroidea in general), as they are similar to those seen in *S. gracilirostris* (NHMUK PV OR 14792), *P. multiscrobiculatus* (SMNS 9930) and *S. bollensis* (SMNS 51753). The only preserved transverse process in MNHNL TU155 is similar to *S. bollensis* (SMNS 51753) in that is it mediolaterally shortened, dorsoventrally flat (although this could be due to preservation) and anteroposteriorly broad. The transverse processes in *P. multiscrobiculatus* (SMNS 9930) are even shorter with a dorsoventrally and anteroposteriorly broad rounded end, which is not seen in MNHNL TU155 (the rounded end is much smaller). In MNHNL TU155, the partial cervical rib is similar to *S. bollensis* (SMNS 51753) in that it is (1) T-shaped, (2) anteroposteriorly elongated and (3) dorsomedially straight. In *P. multiscrobiculatus* (SMNS 9930) and *S. gracilirostris* (NHMUK PV OR 14792), the cervical ribs are not anteroposteriorly elongated to the extent seen in MNHNL TU155 (although those in *S. gracilirostris* NHMUK PV OR 14792 are partially covered by matrix so their full shapes are unclear). The dorsal ribs of MNHNL TU155 have a deep costal groove that begins slightly ventral to the tuberculum, which is similar to both *S. gracilirostris* (NHMUK PV OR 14792) and *S. bollensis* (SMNS 51563). However, the ornamentation of the osteoderms is more similar to that seen in *S. bollensis* (e.g. SMNS 51563). The pits are larger and more irregular than those seen in *S. gracilirostris* (NHMUK PV OR 14792; although this could be due to preservation). The keel is also small but pronounced, as in *S. bollensis* (SMNS 51753, SMNS 51563). This also differs from *P. multiscrobiculatus* (SMNS 9930), in which the pits are small, mainly subcircular and closely situated together. The paramedian osteoderms found in *P. multiscrobiculatus*

(SMNS 9930) are extremely well-developed (being heavily interlocked and large with small, numerous pits), much more so than in any other thalattosuchian. Based on the osteoderm ornamentation, transverse process and cervical rib, we assign MNHNL TU155 to *Steneosaurus* cf. *bollensis*.

STENEOSAURUS BOLLENSIS Jäger, 1828

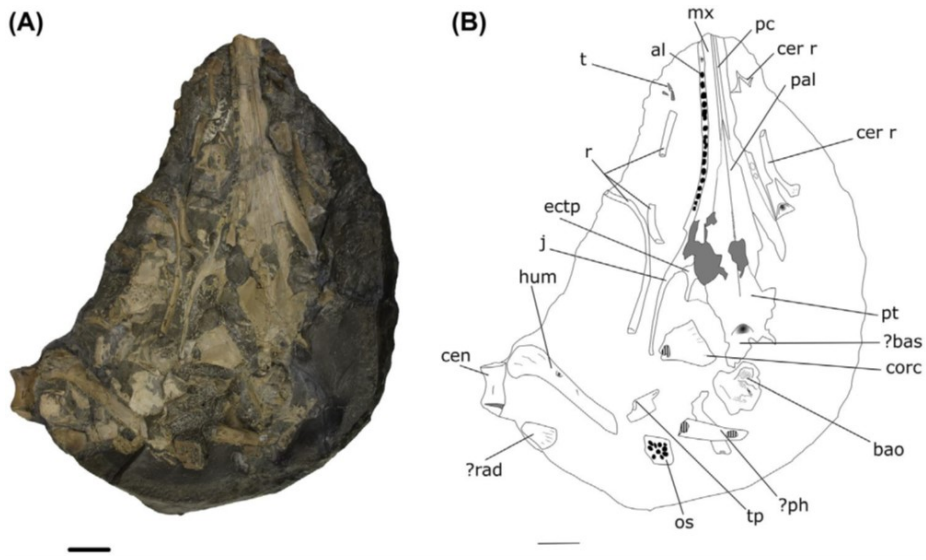


Figure 3. Photograph (A) and line drawing (B) of *Steneosaurus bollensis* (Jäger 1828), MNHNL TU799. Skull in palatal view along with assorted postcranial elements. Refer to the main text for the abbreviations list. Scale bar: 2 cm.

v 1994 *Steneosaurus* sp. – Godefroit, p. 59, 60, pl. 7, fig. 30

Material: a partial skull in palatal view, in addition to five isolated teeth, one humerus, possible partial radius, partial coracoid, rib fragments and partial osteoderms (MNHNL TU799)

Horizon and locality: *Harpoceras serpentinum* ammonite Zone ('*schistes bitumineux*'), Sanem, Luxembourg; Early Toarcian, Early Jurassic.

Description: MNHNL TU799 is a partial skull exposed in palatal view, as well as additional postcranial elements and isolated teeth (Fig. 3). The anterior and posterior portions of the skull are not preserved, as well as the left lateral side. The palate is relatively smooth and unaltered. There is a pair

of well-developed palatal grooves running anteroposteriorly from the anterior of the rostrum to the anterior palatines (Fig. 3).

Maxillae: The maxillae (Fig. 3) are only observed in ventral view. There are approximately 16 preserved on the right side, and a small damaged region posterior to the 16th preserved alveolus may be an additional alveolus, but it is unclear (Fig. 3), and two are preserved on the left side. The alveoli are relatively circular, being slightly mesiodistally longer than mediolaterally wide. They are small and positioned close together with a relatively thin interalveolar wall (smaller than the alveolar width). The tooth row is widely separated from the lateral margin of the choanal opening (Jouve, 2009). There is no ornamentation on the ventral surfaces of the maxillae.

Jugal: The majority of the left jugal is preserved (Fig. 3) except for the posterior end. It forms the lateral border of the orbit, as in other teleosauroids, and is mediolaterally thin.

Basioccipital: The basioccipital (Fig. 3) is poorly preserved and partially covered in matrix. It forms the ventral part of the occiput.

Ectopterygoids: Only the anterior left ectopterygoid is present (Fig. 3) and it is a small bone that contacts the maxilla anteriorly.

Pterygoid: The pterygoid (Fig. 3) is a single, elongated, relatively thin bone. The anteromedial pterygoid has a slight, anteroposteriorly elongated concavity. The anterior processes of the pterygoid contact the posterior processes of the palatines at a mediolateral (horizontal) angle. The pterygoid contributes to the medial and posterior borders of the sub-orbital fenestrae, which are small, rounded posteriorly and teardrop-shaped with a lateral curvature (Fig. 3). The pterygoid wings are not preserved.

Basisphenoid: The basisphenoid (Fig. 3) is poorly preserved, but appears to be anteroposteriorly short (Godefroit, 1994). It contacts the pterygoid anteriorly.

Palatines: The paired palatines (Fig. 3) are long, thin bones that are smooth, unaltered and V-shaped. There is a well-developed palatal suture that

separates the palatines, more so posteriorly (in which it displays a sharply defined, ‘zig-zagging’ appearance). The palatines contact one another along the skull midline until they are separated posteriorly by the anterior process of the pterygoid.

Dentition: There are five isolated teeth preserved close to the right anterior part of the rostrum (Fig. 3). The teeth are slender and small, with a pointed apex and well-developed carinae. There are no serrations present. The enamel ridges are faint, numerous, parallel and extend for the entire apicobasal length of the tooth.

Postcranial: Vertebrae and ribs: There is one complete centrum (Fig. 3) preserved in ventral and lateral views. The centrum is amphicoelous and slightly hourglass-shaped. There is one partially preserved distal end of a transverse process (Fig. 3), which includes the small, circular, laterally-facing articulation surface of the rib head (which is separated from the centrum by a small concavity). There is one partially preserved cervical rib (Figure 3), which has a straight dorsomedial margin. The tuberculum and capitulum are both large and rounded and the proximal area in front of them is considerably elongated. There is only one nearly complete dorsal rib (Fig. 3) which is mediolaterally thin, with a rounded capitulum. The rib neck is also elongated and thin, and the sternal end is mediolaterally flat and straight. Only the lateral surface is preserved, so the tuberculum and costal groove are not visible.

Front limb: The proximal area of the coracoid is preserved (Fig. 3). It is thin and flat, and mediolaterally elongated. The humerus (Fig. 3) is of typical teleosauroid size of approximately 13 cm proximodistal length (Andrews, 1913). However, the humeral head is proximodistally elongated and curved, with a well-pronounced deltopectoral crest. The shaft of the humerus is straight and the distal end is rounded.

Osteoderms: Only small fragments of dorsal osteoderms (Fig. 3) are preserved. The pits are semicircular and shallow, and are irregularly arranged.

Discussion: Godefroit (1994) assigned MNHNL TU799 to *Steneosaurus* based on the structure of the palate, and gave a brief description of the preserved cranial bones. However, Rupert Wild (Stuttgart) labelled MNHNL TU799 as '*Steneosaurus bollensis*' in the museum catalogue in 2000, during an informal visit of the collections (no publication or publication project followed). Nevertheless, we do agree that MNHNL TU799 belongs to *S. bollensis*, based on the following observations:

1. Small, circular alveoli, especially in the posterior maxillae, with small interalveolar spacing (similar to unnumbered YORM *S. bollensis*). The alveoli are also small and subcircular in *S. gracilirostris* specimens (e.g. NHMUK PV R 757), although the interalveolar spacing is larger. The interalveolar spacing in *S. brevior* (NHMUK PV OR 14781) is also larger (longer than the alveolus width).
2. Small tear-shaped choanal openings being relatively the same size as the orbit, which is strongly, posterolaterally curved (as seen in unnumbered YORM *S. bollensis*). The sub-orbital openings in *S. gracilirostris* (MNHNL TU515, NHMUK PV R 757) appear to lack this curvature (although these specimens are poorly preserved in this area).
3. Palatines are anteroposteriorly elongated, anteromedially constricted and V-shaped, as opposed to *S. gracilirostris* (YORM 1994.3163.1, NHMUK PV R 757) in which the palatines are shorter, lack anteromedial constriction and are more U-shaped (the palatines are not visible in *P. multiscrobiculatus* SMNS 9930 and *S. brevior* NHMUK PV OR 14781).
4. Well-developed, tightly interlocking palatal suture, with a characteristic 'zig-zagging' appearance in the posterior area (as seen in unnumbered YORM *S. bollensis*). In *S. gracilirostris* (NHMUK PV R 5703, YORM 1994.3163.1), the suture is straight and not tightly interlocking (the palatal suture is not visible in *P. multiscrobiculatus* SMNS 9930 and *S. brevior* NHMUK PV OR 14781).

5. A mediolaterally thin jugal with a noticeable lateral bulge (as seen in SMNS 53422, SMNS 57153, OUMNH JZ176), which is absent in *S. gracilirostris* (NHMUK PV R 757, MNHNL TU515) and *P. multiscrobiculatus* (SMNS 9930). This bulge is ventrolaterally present in *S. brevior* (NHMUK PV OR 14781) and in some specimens of *S. bollensis* (e.g. SMNS 51753) (note that this feature may be based on preservation).
6. A relatively large and proximodistally elongated humeral head with a distinct proximal curvature (as seen in *S. bollensis* SMNS 53422, SMNS 51753, SMNS 51957). The humeral head in *S. gracilirostris* (NHMUK PV OR 14792) and *P. multiscrobiculatus* (SMNS 9930) is not elongated nor as curved.

STENEOSAURUS GRACILIROSTRIS (Westphal 1961)

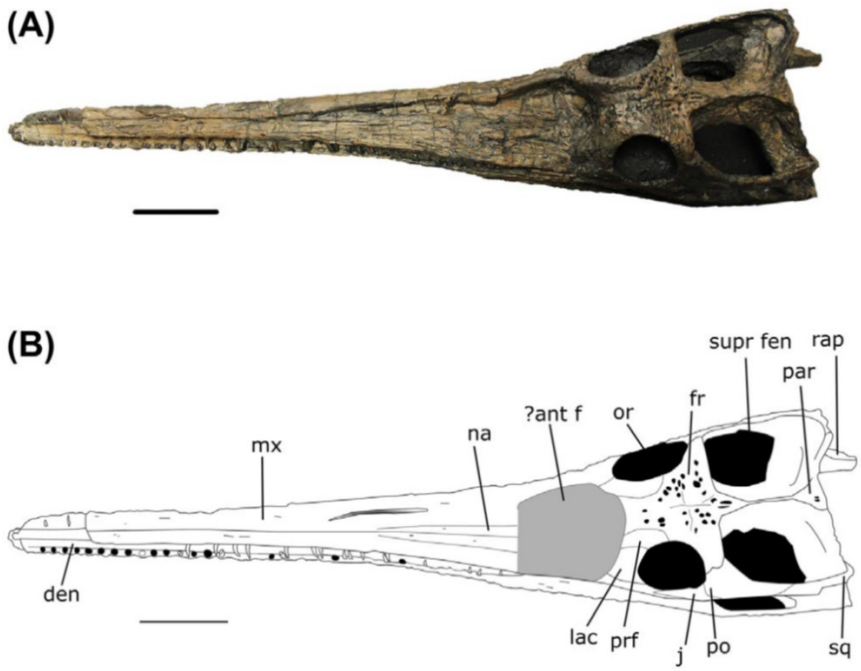


Figure 4. Photograph (A) and line drawing (B) of *Steneosaurus gracilirostris* (Westphal 1961), MNHNL TU515. Nearly complete skull in dorsal view. Refer to the main text for the abbreviations list. Scale bar: 5 cm.

v 1994 *Steneosaurus gracilirostris* Westphal – Godefroit, p. 50–54, pl. 5, fig. 27

Material: a nearly complete skull and dentary (MNHNL TU515).

Horizon and locality: *Harpoceras serpentinum* ammonite Zone ('*schistes bitumineux*'), Dudelange-Bettembourg in southern Luxembourg; Early Toarcian, Early Jurassic.

Description: MNHNL TU515 is a nearly complete skull and mandible (Figs. 4–8) (Godefroit, 1994). The skull and mandible are cemented together with matrix, so the cranial palatal surface and mandibular dorsal surface are not accessible. The cranium is approximately 56.9 cm in length; however, the premaxillae and anterior areas of the maxillae are not preserved. The remaining cranial rostrum is severely dorsoventrally flattened and there is extreme dorsoventral crushing just anterior to the orbits (Figs. 4–6), but the posterior cranium is well preserved (Fig. 7). The orbits are large and comprise approximately 53% of the supratemporal fenestrae length (Figs. 4–6). The foramen magnum is large and elliptical in shape (Fig. 7).

Maxillae: The maxillae (Figs. 4–6) form a substantial part of the rostrum (although this is difficult to see in right lateral view due to deformation of the cranium (Fig. 6)). The nasals are separated from the premaxillae by the maxillae. The actual maxillary tooth count is difficult to determine but there are approximately 28 to 30 visible alveoli pairs (as opposed to other *S. gracilirostris* specimens (e.g. NHMUK PV R 5703 and YORYM 1994.3163.1) which have approximately 32 alveoli pairs). The lateral surface of the maxilla is ornamented with small faint grooves (Figs. 5 and 6). The maxillary tooth row ends anterior to the anterior-most border of the sub-orbital fenestra. There are no deep reception pits for dentary teeth. The exact sizes of the antorbital fenestrae (Figs. 4 and 5) are difficult to determine due to multiple cracks and severe crushing in the area anterior to orbits (although they are presumed to be large and anteroposteriorly elongated, as in NHMUK PV OR 14792; Godefroit, 1994).

Jugals: The jugals (Figs. 4–6) are triradiate and form the lateral margin of the orbit as in other teleosauroids (Andrews, 1909). The anterior jugal is short and does not extend anteriorly past the orbits (Figs. 5 and 6). The majority of the posterior right jugal is not preserved. The postorbital-jugal contact appears to be anteroposteriorly straight and is better seen in left lateral view (Fig. 5).

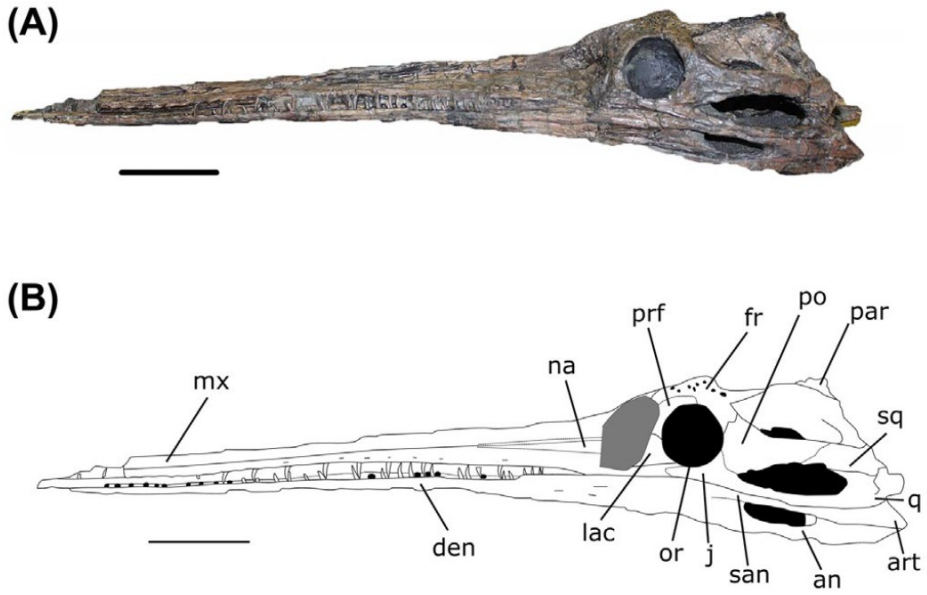


Figure 5. Photograph (A) and line drawing (B) of *Steneosaurus gracilirostris* (Westphal 1961), MNHNL TU515. Nearly complete skull in left lateral view. Refer to the main text for the abbreviations list. Scale bar: 5 cm.

Nasals: The nasals (Figs. 4–6) are slender triangular bones that comprise the dorsal posterior rostrum and orbital area. There is little ornamentation on the dorsal nasals, consisting of small faint ridges. While difficult to see, there is a faint internasal suture (Figs. 4 and 5), suggesting that the nasals are paired or partially fused (similar to NHMUK PV OR 14792 and YORYM 1994.3163.1). The posterior nasals are severely deformed, as mentioned above. The anteroposterior length of the nasals is relatively short in comparison with the anteroposterior length of the maxillae (roughly 47%, but due to deformation of the posterior nasals and missing anterior rostrum this number is not reliable) (Figs. 4–6).

Prefrontals: The prefrontals (Figs. 4 and 5) are severely distorted due to crushing (slightly anterior to the orbits, as mentioned above). Therefore, the majority of the anterior ends of the prefrontals cannot be properly assessed. However, it is clear that the prefrontal forms the anteromedial corner of the

orbit (Fig. 4) and contacts the frontal medially, as in other teleosauroids (Andrews, 1909, 1913). The visible prefrontal-lacrimal contact is relatively straight (Figs. 4–6).

Frontal: The frontal (Figs. 4–6) is large and has no evidence of a midline suture. The anterior end of the frontal is distorted and slopes ventrally due to anterior crushing. The frontal contributes to the posteromedial border of the orbits, forms the anterior medial borders of the supratemporal fenestrae and forms a relatively straight vertical contact with the postorbital in dorsal and lateral views (Figs. 4 and 5). The dorsal ornamentation of the frontal consists of numerous small, but deep, circular-to-semicircular pits that radiate outwards from the midline (Fig. 4).

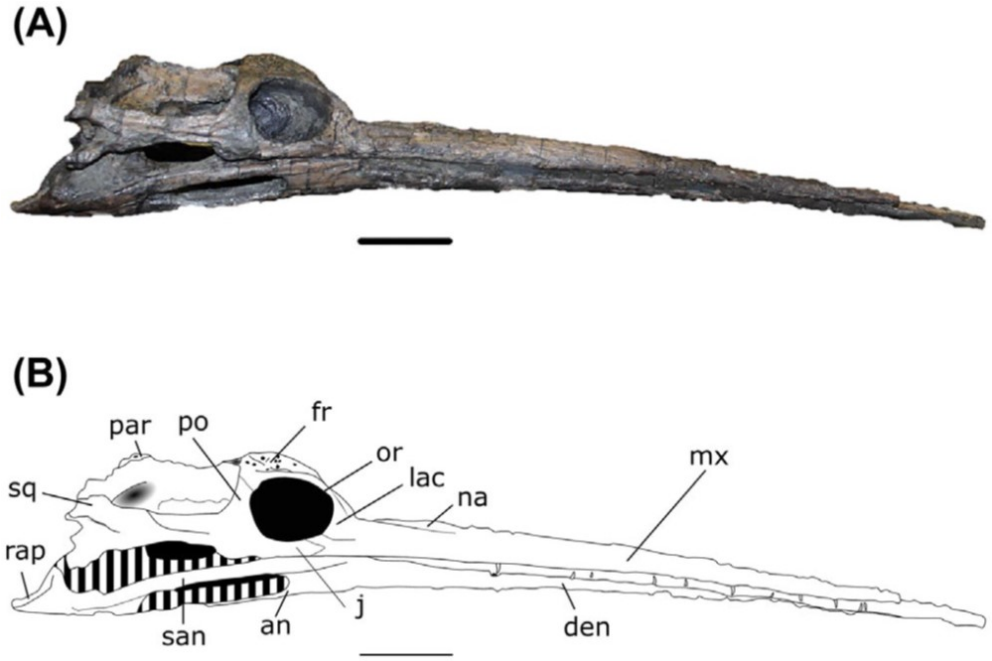


Figure 6. Photograph (A) and line drawing (B) of *Steneosaurus gracilirostris* (Westphal 1961), MNHNL TU515. Nearly complete skull in right lateral view. Note that shaded (striped) lines represent ironstone matrix. Refer to the main text for the abbreviations list. Scale bar: 5 cm.

Postorbitals: The postorbitals (Figs. 4–6) are large and robust, and form the lateral and posteroventral borders of the supratemporal fenestrae. In lateral view, the dorsoventral suture of the postorbital contacts the squamosal and the anterodorsal sutures are tightly interdigitated with the frontal. The frontal-postorbital contact forms the postorbital bar, which is anteroposteriorly thick

and mediolaterally short (Fig. 4). It forms the posterolateral margin of the orbit. Also in lateral view the anterodorsal area of the postorbital is slightly anteroposteriorly constricted (Figs. 5 and 6), whereas the rest of it is anteroposteriorly broad as in other teleosauroids. The postorbital-jugal contact is difficult to discern (more so on the right side) but it appears to be slightly ventrolaterally oriented in dorsal and lateral views (Figs. 4–6). The postorbital is mediolaterally shortened, as opposed to the condition in most other teleosauroids (e.g. *Steneosaurus leedsi* Andrews, 1913), and noticeably larger than the squamosal (Figs. 4–6).

Parietal: The parietal (Figs. 4–7) is relatively large and robust, and has slight dorsal ornamentation which consists of two or three elliptical pits. There is no trace of a midline suture. The parietal contributes to the posterior and medial borders of the supratemporal fenestrae and does not overhang the occiput in dorsal or occipital view. It is mediolaterally thickened.

Squamosals: The squamosals (Figs. 4–6) are L-shaped; the anterior processes are anteroposteriorly elongated (in dorsal view), and form the posterolateral border of the supratemporal fenestrae. Its posterolateral surface is concave and it contacts the quadrate posteroventrally in lateral view. The squamosal anteriorly contacts the postorbital, and together they form the supratemporal arch.

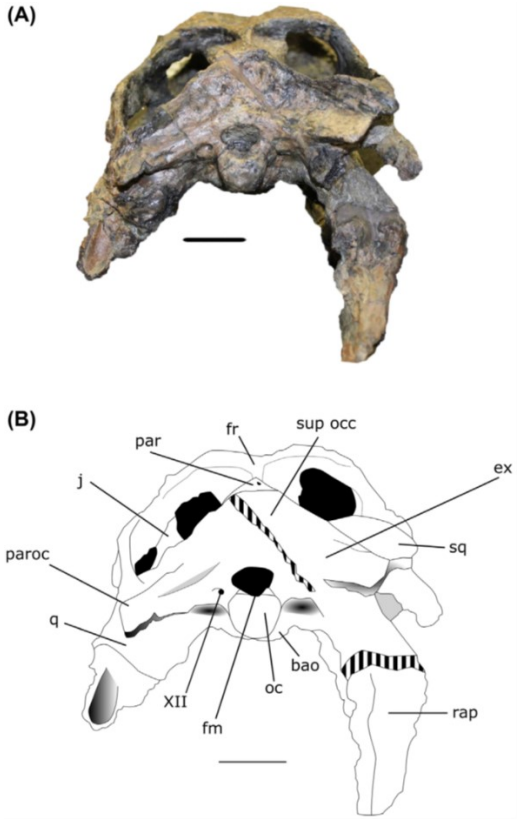


Figure 7. Photograph (A) and line drawing (B) of *Steneosaurus gracilirostris* (Westphal 1961), MNHNL TU515. Nearly complete skull in occipital view. Note that shaded (striped) lines represent ironstone matrix. Refer to the main text for the abbreviations list. Scale bar: 3 cm.

Quadrates: The quadrates (Figs. 5, 7) are robust and strongly sutured to the squamosals and quadratojugals. The anterodorsal region of the quadrate contacts the squamosal and quadratojugal while the posteroventral margin articulates with the angular (=jaw joint) and medially contacts the exoccipital. The posteroventral medial hemicondyle is slightly larger than the lateral hemicondyle in size and mediolateral length. Both hemicondyles are elongated mediolaterally, oval-shaped and have rounded posterior edges. On the occiput, the hemicondyles posteriorly extend further than the exoccipitals (Fig. 7). The left quadrate is well-preserved whereas the right quadrate is missing the hemicondyles.

Quadratojugals: The quadratojugals are visible in lateral view, with the left being better preserved than the right. The posterior region of the quadratojugal is expanded mediolaterally to accommodate the quadrate and

extends slightly further posteriorly than the posteroventral corner of the quadrate.

Supraoccipital: The supraoccipital (Fig. 7) is positioned ventral to the parietal and is only visible in occipital view. It forms the dorsomedial part of the occiput and contributes to the dorsal edge of the foramen magnum (Fig. 7) (Brusatte et al., 2016). The ventral edge is triangular and no nuchal crest is present. The supraoccipital is dorsoventrally tall and slightly mediolaterally expanded (more so dorsally than ventrally). The supraoccipital is not broadly exposed in dorsal view and is slightly concave.

Exoccipital: The exoccipitals (Fig. 7) make up the majority of the occiput (Godefroit, 1994), are tilted dorsally, flared mediolaterally and are slightly concave on their occipital surfaces. Both exoccipitals are strongly directed posteriorly (although this may be due to preservation). The exoccipitals are dorsoventrally tall and mediolaterally short compared to other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806), and contribute to the dorsal and lateral borders of the foramen magnum. Laterally the exoccipitals descend rapidly, making them appear box-like in occipital view. The paraoccipital process is rounded and the same size as the rest of the exoccipital, giving it a paddle-shaped appearance in occipital view (Fig.7). The foramina for cranial nerves XII are large, situated laterally, are housed in an oval-shaped fossa and are parallel to the foramen magnum (Fig. 7) (Brusatte et al., 2016). There is a small, circular foramen on the dorsomedial surface of the left exoccipital (Fig. 7).

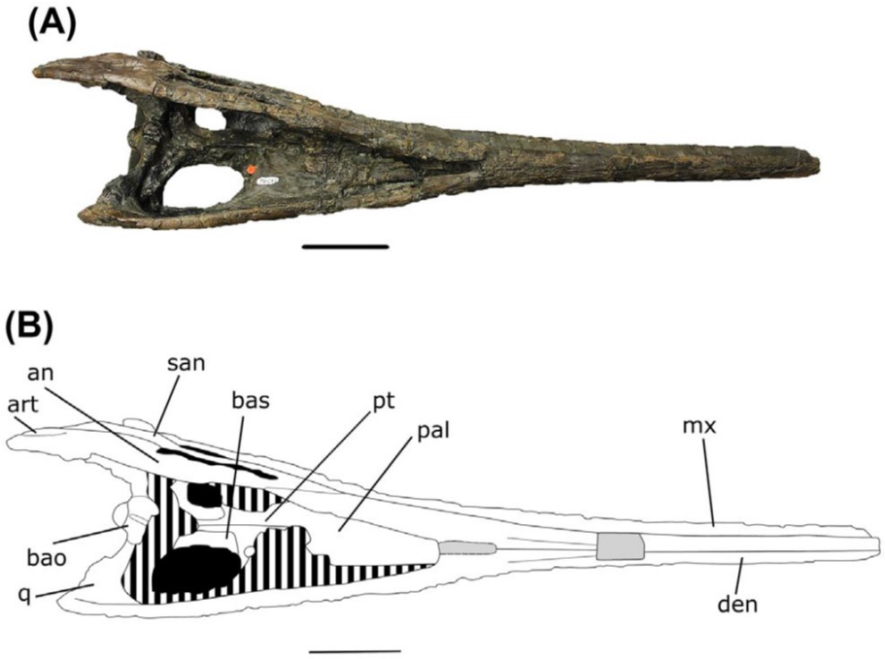


Figure 8. Photograph (A) and line drawing (B) of *Steneosaurus gracilirostris* (Westphal 1961), MNHNL TU515. Nearly complete skull in ventral view. Note that shaded (striped) lines represent ironstone matrix. Refer to the main text for the abbreviations list. Scale bar: 5 cm.

Basioccipital: The basioccipital (Fig.7 and 8) forms the ventral part of the occiput (Godefroit, 1994). The basioccipital contributes to the foramen magnum and is slightly wider than tall. The occipital condyle is large and more circular than the foramen magnum (Fig. 7). The sutures between the occipital condyle and the basioccipital are not visible. There is a small circular foramen ventrolateral to cranial nerve XII and anterior to the occipital condyle on the left side of the basioccipital.

Pterygoid: Both pterygoid wings are not preserved, and the remaining pterygoids are covered in a hard sheet of ironstone matrix, making it difficult to discern shape and sutures (Fig. 8). However, the pterygoid appears to be thin and mediolaterally expanded, as in other teleosauroids (Andrews, 1913). The suborbital fenestrae are also covered in matrix and are not visible.

Basisphenoid: The entirety of the area where the basisphenoid should be present is covered in matrix (Fig. 8) and the posterior surface is slightly deformed. It is difficult to determine if the basisphenoid is indeed preserved, or if the posterolateral processes are the only structures that are not preserved.

Other elements: The palatines are visible in ventral view but are completely covered in matrix (Fig. 8) and therefore difficult to describe properly. The ectopterygoids are not preserved. The proötics and laterosphenoids are not visible and therefore cannot be described.

Mandible: The nearly complete mandible of MNHNL TU515 (Figs. 4–6, 8) is cemented to the cranium so the dorsal surface is not visible, as mentioned above. It measures 73.6 cm in length; however, the anterior-most part of the mandible is not preserved. Multiple areas of the ventral mandible are covered in ironstone matrix, most notably where the anterior mandibular symphysis begins (Fig. 8).

Dentary: The dentary (Figs. 4–6, 8) is an elongate, slender bone that makes up the majority of the lateral and ventral surfaces of the mandible, as in the majority of crocodylomorphs (Andrews, 1909, 1913; Romer, 1956; Nesbitt, 2011; Johnson et al., 2017). The anterior-most dentary is not preserved. The exact number of alveoli is difficult to discern but there are approximately 29 alveoli per side (although the anterior-most dentary is missing). Due to slight lateral displacement of the maxillae, at least 19 alveoli are seen in dorsal view on the left dentary (Fig.4). The alveoli are small and relatively circular, with the interalveolar distance being slightly larger than the alveolar labiolingual width.

Surangular and angular: In lateral view, the surangular (Figs. 5 and 6) is a thin and anteroposteriorly elongate bone. In conjunction with the angular and articular, the surangular is anteroposteriorly elongated and appears to form a distinctive ‘V’ shape. In lateral view, the combined bones extend much farther posteriorly than the posterior cranium (Fig. 6). The anterior surangular terminates near the final alveolus of the dentary. The angular (Figs. 5 and 6) occupies a larger area than the surangular and is ventral to it. The angular is dorsoventrally deeper and more robust than the surangular and has a poor dorsal curvature in lateral view. It articulates with the retroarticular process of the articular.

Articular: The left articular is not preserved. The right retroarticular process is anteroposteriorly elongate, mediolaterally thin and triangular-shaped in dorsal

view (Figs. 6and 7). The anteroposterior keel is small and thin but visible. The posterior end of the retroarticular process is slightly rounded.

Dentition: Both the maxillary and dentary teeth (Figs. 4–6) are small, slender and elongated with a pointed apex. They are strongly posteriorly curved. The enamel ridges are slight, faint, parallel to one another and do not reach the top of the apex. There are no serrations present.

Discussion: MNHNL TU515 displays many characteristic features of teleosauroids including: a relatively small frontal and anteroposteriorly elongated supratemporal fenestrae (Andrews, 1913; Johnson et al., 2017). Godefroit (1994) referred MNHNL TU515 to *Steneosaurus gracilirostris* based on: (1) the elongation and slender build of the skull; (2) the considerable anteroposterior length of the antorbital fenestrae; (3) the lateral position of the orbits; and (4) location of dorsal ornamentation (restricted to the frontal, postorbitals, parietal and posterior area of the prefrontals). We agree with Godefroit's (1994) referral (although the actual size of the antorbital fenestrae is difficult to discern, due to the deformation of the skull; see description), and here list how MNHNL TU515 is similar to the *S. gracilirostris* holotype (NHMUK PV OR 14792) and paratype (NHMUK PV R 15500) based on the following characters:

1. A medium-sized skull (roughly 2 m in length) with an elongated narrow rostrum comprising at least 70% of the total skull length (although the total length of the skull varies). The rostra in *S. bollensis* (SMNS 51953), *P. multiscrobiculatus* (SMNS 9930), and *S. brevior* (NHMUK PV OR 14781) contribute to less than 70% of the total skull length.
2. Anteroposteriorly elongated maxillae and no elongation of the nasals, with a maxilla that is over 55% of skull length. This is similar to *S. bollensis* (SMNS 51953) and *P. multiscrobiculatus* (SMNS 9930), but differs in *S. brevior* (NHMUK PV OR 14781) in which both the maxillae and nasals are not as elongated and the maxilla is less than 55% of the skull length (note that *S. brevior* (NHMUK PV OR 14781) is a mesorostrine form).

3. Laterally (and slightly dorsally) facing orbits. This character makes *S. gracilirostris* unique amongst teleosauroids (this character is also shared with metriorhynchoids). *Steneosaurus bollensis* (SMNS 51953), *S. brevior* (NHMUK PV OR 14781) and *P. multiscrobiculatus* (SMNS 9930) all have orbits that are dorsally oriented.
4. The tooth row and quadrate condyle are aligned on the horizontal plane, and are both at a lower level than the occipital condyle. While this is similar to *S. bollensis* (SMNS 51753), in *P. multiscrobiculatus* (SMNS 9930) both the tooth row and quadrate are unaligned (with the quadrate being slightly ventral to the tooth row) and below the occipital condyle. In *S. brevior* (NHMUK PV OR 14781), the tooth row and quadrate condyle appear to be unaligned.
5. Nasals lack a midline concavity (although they are severely flattened). In *S. brevior* (NHMUK PV OR 14781), *S. bollensis* (SMNS 51953) and *P. multiscrobiculatus* (SMNS 9930) this concavity is present (note that the holotype of S. gracilirostris (NHMUK PV OR 14792) also has this concavity).
6. The antorbital fenestrae appear to be moderately large and anteroposteriorly elongated (roughly 3 cm anteroposterior length), which is seen in the holotype (NHMUK PV OR 14792) (although MNHNL TU515 is severely deformed in these areas). *Steneosaurus bollensis* (SMNS 51953), *S. brevior* (NHMUK PV OR 14781) and *P. multiscrobiculatus* (SMNS 9930) all have smaller, subcircular antorbital fenestrae.
7. At least 29 maxillary alveoli, which is similar in *S. bollensis* (although the number of alveoli can vary from 28 to over 32). The exact tooth count of *S. brevior* (NHMUK PV OR 14781) is difficult to discern but it has fewer than 28 maxillary alveoli.
8. Longitudinal, ellipsoid supratemporal fenestrae that show no anterolateral expansion. While this is similar to *S. bollensis* (SMNS 51953), in *S. brevior* (NHMUK PV OR 14781) and *P. multiscrobiculatus* (SMNS 9930) the anterior margin of the supratemporal fenestrae are inclined anterolaterally.

9. In dorsal view, the supratemporal fenestrae are subequal in size relative to the orbit. In *S. bollensis* (SMNS 51953), *P. multiscrobiculatus* (SMNS 9930) and *S. brevior* (NHMUK PV OR 14781) the supratemporal fenestrae are longer in length than the orbit.
10. The anterior jugal is broad, with a roughly straight contact with the maxilla and does not extend anteriorly past the level of the orbit. In *S. bollensis* (SMNS 20283, NHMUK PV R 756), *S. brevior* (NHMUK PV OR 14781) and *P. multiscrobiculatus* (SMNS 9930), the anterior jugal tapers off dorsoventrally just anterior to the orbits in lateral view.
11. The squamosal projects further posteriorly than the occipital condyle. This is similar to *S. brevior* (NHMUK PV OR 14781); however, in *S. bollensis* (SMNS 51953) the squamosal does not project further posteriorly than the occipital condyle.
12. Angular is poorly curved (mostly horizontal) dorsally at its posterior end. This is similar to *S. brevior* (NHMUK PV OR 14781); however, in *S. bollensis* (SMNS 51563) and *P. multiscrobiculatus* (SMNS 9930) the angular yet clearly is gently curved.
13. Mandible is poorly curved ventrally and the dorsal border is generally straight. In *S. brevior* (NHMUK PV OR 14781) and *P. multiscrobiculatus* (SMNS 9930), the mandibular dorsal border is gently dorsally arched.

PLATYSUCHUS MULTICROBICULATUS (Berckhemer, 1929) Westphal, 1961

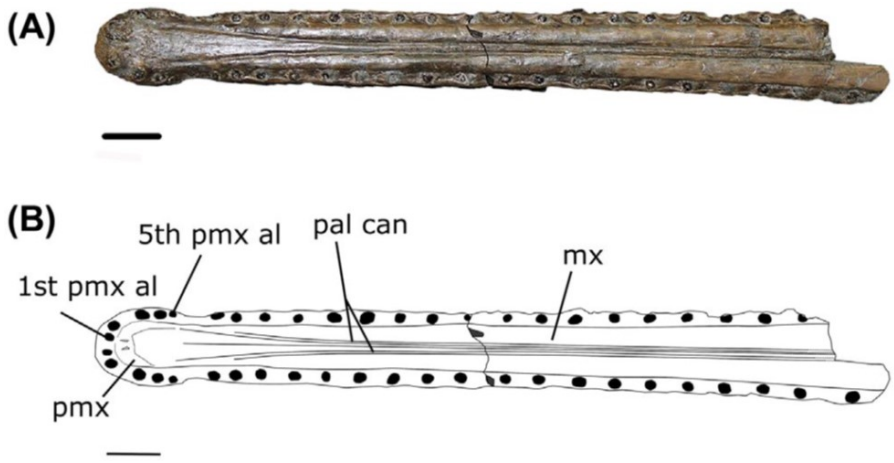


Figure 9. Photograph (A) and line drawing (B) of *Platysuchus multiscrobiculatus* (Berckhemer 1929) Westphal, 1961, MNHNL TU895. Anterior rostrum in palatal view. Note the characteristic five alveoli per premaxilla. Refer to the main text for the abbreviations list. Scale bar: 1 cm.

Material: a partial anterior rostrum (MNHNL TU895) preserved in ventral view.

Horizon and locality: *Harpoceras serpentinum* ammonite Zone ('*schistes bitumineux*'), Foetz, Luxembourg; lower Early Toarcian, Early Jurassic.

Description: The premaxillae (Fig. 9) are anteroposteriorly taller than mediolaterally wide and are slightly scoop-shaped in appearance. The anterior two-thirds of the premaxillae are not laterally expanded (as in other teleosauroids; see Johnson et al., 2017), although this may be due to preservation. There are five premaxillary alveoli preserved (Fig. 9). The third premaxillary alveolus is not enlarged relative to the second and fourth alveoli. There is a large interalveolar lamina between the second and third alveoli, as well as a smaller one between the third and fourth alveoli. The fourth and fifth premaxillary alveoli are separated by a thin interalveolar lamina. There is an elongated diastema between the fifth premaxillary alveolus and the first maxillary alveolus. MNHNL TU895 also includes a second slab of an imprint of the rostrum that clearly displays the five premaxillary alveoli. The precise maxillary tooth count is unknown but there are at least 18 maxillary alveoli preserved on each side. The palatal canals (Fig. 9) are well preserved, thin, extend from the fourth premaxillary alveoli, and continue posteriorly down the midline of the maxillae.

Discussion: The teleosauroid rostrum MNHNL TU895 was never formally classified and was initially labelled in the museum catalogue as 'crocodilian rostrum (by private collector and discoverer of the specimen, M. Jo Simon, also a volunteer research associate of the MNHNL). However, there is a critical character seen in MNHNL TU895: five distinct alveoli per premaxilla (although it is noticeably harder to make out all alveoli on the right side). Other Toarcian teleosauroids such as *S. bollensis* (e.g. SMNS 18699), *S. brevior* (NHMUK PV OR 14781) and *S. gracilirostris* (NHMUK PV R 5703) have four premaxillary alveoli per side. The size of the alveoli also differ: in MNHNL TU895, the first two alveoli are similar in size, whereas in *S. bollensis* (SMNS 18699) the first alveolus is slightly smaller than the second. This character is diagnostic and, in Toarcian teleosauroids, is only present in *P. multiscrobiculatus* (SMNS 9930). Therefore, we attribute MNHNL TU895 to *P. multiscrobiculatus*.

TELEOSAUROIDEA INDET

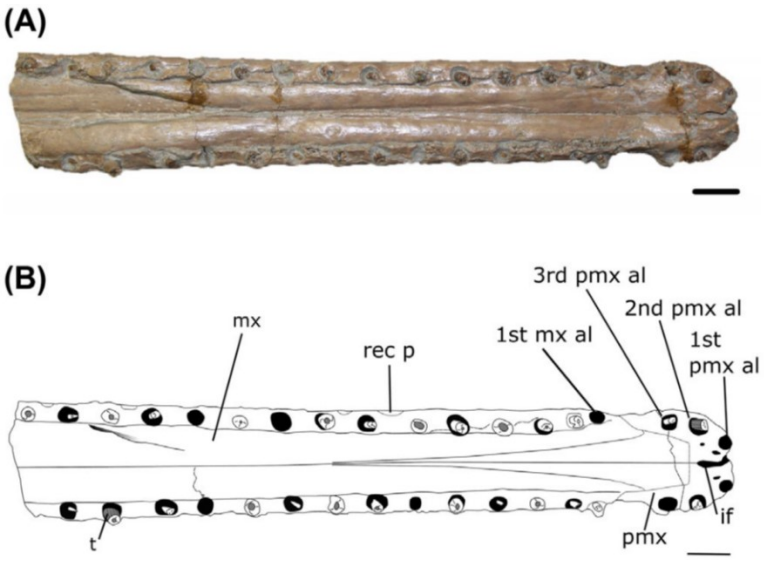


Figure 10. Photograph (A) and line drawing (B) of Teleosauroidea indeterminate, MNHNL TU164. Anterior rostrum in palatal view. Note the three alveoli per premaxilla. Refer to the main text for the abbreviations list. Scale bar: 1 cm.

Material: a partially complete anterior rostrum in palatal view (MNHNL TU164).

Horizon and locality: *Harpoceras serpentinum* ammonite Zone ('*schistes bitumineux*'), Dudelange-Bettembourg in southern Luxembourg; Early Toarcian, Early Jurassic.

Description: MNHNL TU164 (Fig. 10) is the anterior end of the rostrum and is approximately 18.7 cm in length. Once peculiar feature is there are only three alveoli per premaxilla (Fig. 10). All premaxillary alveoli are relatively the same size, with the second being slightly larger than the first. The first premaxillary alveolus is procumbent. There is a large diastema present between the last premaxillary and first maxillary alveoli. There are 14 and 15 preserved maxillary alveoli on the right and left sides, respectively, that are large and semicircular, with a large interalveolar spacing between them (slightly larger than the alveolar width). In ventral and lateral views (more so on the right side), there are faint but well-developed reception pits for dentary teeth along the middle region of the ventral-lateral margin of the maxillae (Fig. 10) The prenarial anterior premaxillary ridge, seen in anteroventral view, is well-developed and, while relatively small, well pronounced. There are three partial teeth associated with MNHNL TU164: one in situ in the right second premaxillary alveolus, one in the left thirteenth maxillary alveolus (Fig. 10) and one embedded in an opposing slab. The apices are not preserved in any of the teeth; however, the apicobasal enamel ridges are small, well pronounced, numerous and run parallel to one another towards the apex of the tooth (Fig. 10). There are no carinae preserved.

Discussion: MNHNL TU164 was initially labelled as '*Steneosaurus bollensis*' by Rupert Wild (Stuttgart) in 2000 (this was an informal determination and there was no publication). However, MNHNL TU164 has an unusual character: only three alveoli per premaxilla, as opposed to *P. multiscrobiculatus* (MNHNL TU895, SMNS 9930), which has five, and *S. bollensis* (SMNS 18699), *S. gracilirostris* (NHMUK PV R 5703) and *S. brevior* (NHMUK PV OR 14781), which all have four. It is important to note that in Teleosauroidea, only the genus *Machimosaurus* is known to have three alveoli per premaxilla (Young et al., 2014a). While the teleosauroid referred to as '*Peipehsuchus*' *teleorhinus* Young, 1948, from China (see Li, 1993) is described as having three premaxillary alveoli, the specimen (IVPP 10098) in

actuality has four (the first premaxillary alveolus is much smaller than the other three). Three premaxillary alveoli is a synapomorphy of Metriorhynchidae; however, the (1) shape of the anterior maxilla in palatal view (straightened and sub-rectangular, as opposed to tapering and sub-triangular in metriorhynchids), (2) overall shape of the premaxillae (spatulate) and (3) spacing (large interalveolar distance) between premaxillary alveoli are more representative of a teleosauroid than metriorhynchid. In addition, MNHNL TU164 has small yet noticeable reception pits, which are absent in *S. bollensis* (SMNS 51753, SMNS 18699), *P. multiscrobiculatus* (SMNS 9930) and *S. gracilirostris* (NHMUK PV OR 14792) (although these are present in *S. brevior* (NHMUK PV OR 14781). The presence of three premaxillary alveoli could potentially be a character diagnostic of a new species of teleosauroid, because MNHNL TU164 is the only currently known Toarcian teleosauroid with this feature. However, more specimens are necessary to demonstrate that this is a taxonomically diagnostic feature and not individual or random variation. Therefore, at the current time, we assign MNHNL TU164 to Teleosauroidea indet., but recognise that it may belong to a previously unknown species.

TELEOSAUROIDEA INDET

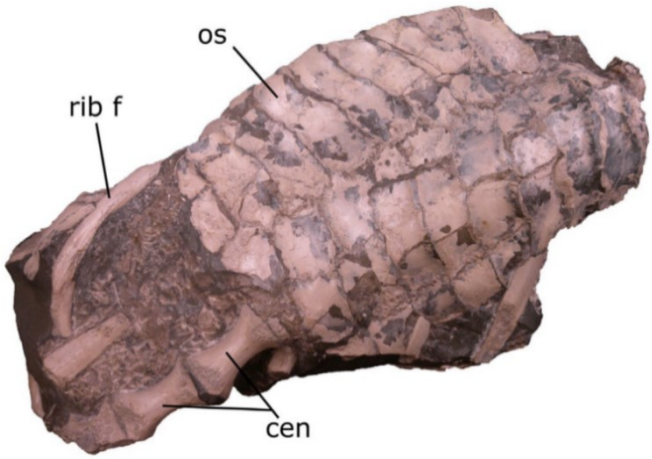


Figure 11. Photograph of Teleosauroidea indeterminate, MNHNL TV116. Refer to the main text for the abbreviations list. The photograph of MNHNL TV116 was provided by R. Weis from the museum database, and no scale bar is present.

Material: a large slab including: articulated osteoderms, rib fragments and two ?dorsal vertebrae (MNHNL TV116).

Horizon and locality: *Harpoceras serpentinum* ammonite Zone ('*schistes bitumineux*'), Dudelange-Bettembourg, Luxembourg; Early Toarcian, Early Jurassic.

Description: The centra of two (possibly dorsal) vertebrae (Fig. 11) are preserved and are only seen in ventral and lateral views. They are both strongly hourglass-shaped and are mediolaterally constricted in ventral view. The rib fragments contain little information, as they are partial pieces and surrounded by matrix. However, they are of typical thalattosuchian shape (such as *S. bollensis* MMG BwJ 595) and have a shallow costal groove. The osteoderms (Fig. 11) form an articulated partial sheath, in parallel rows of two, and are seen in ventral view. The ventral surface is smooth and unornamented.

Discussion: Currently the location of MNHNL TV116 is unknown. It is possible that it is hidden underneath inaccessible collection material, as it was previously on exhibition in a local museum, which has since been closed. MNHNL TV116 includes articulated osteoderms (in addition to smaller fragments) in ventral view; the surfaces of the osteoderms are smooth and unaltered, similar to those seen in other teleosauroids (e.g. *S. bollensis* SMNS 53422; *Mycterosuchus nasutus* Andrews 1913, NHMUK PV R 3577). Due to the limited view of MNHNL TV116 examined by our team, and the fact that it has not been personally examined, it is difficult to confidently identify. Therefore, we assign MNHNL TV116 to Teleosauroidea indet.

TELEOSAUROIDEA INDET

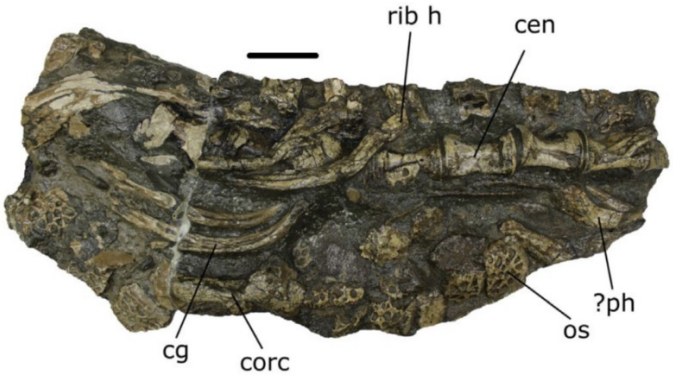


Figure 12. Photograph of Teleosauroidea indeterminate, MNHNL TV209. Note the thickened coracoid. Refer to the main text for the abbreviations list. Scale bar: 5 cm.

Material: a large slab including: six vertebrae, dorsal rib fragments, phalanges, a coracoid and 21 osteoderms (MNHNL TV209).

Horizon and locality: *Harpoceras serpentinum* ammonite Zone ('*schistes bitumineux*'), Dudelange-Bettembourg, Luxembourg; Early Toarcian, Early Jurassic.

Description: The coracoid (Fig. 12) is of typical teleosauroid shape (Andrews, 1913); however, the distal end is not mediolaterally flared (although this could be due to preservation). The coracoid shaft is also noticeably thicker than in teleosauroids such as *S. bollensis* (SMNS 5173). The proximal and distal ends are similar in mediolateral length, with the distal end being slightly larger. The (likely dorsal) vertebral centra (Fig. 12) are approximately 5.2 cm in length and are spool-shaped. The ventral margins of the anterior and posterior articulation surfaces of the centra are well rounded. There are six nearly complete dorsal ribs (in addition to fragments), all of which have a deep costal groove (Fig. 12). The sternal rib end is flat, narrows substantially and is rounded. There are twenty-one osteoderms preserved, and only seven are complete. The pits (Fig. 12) are deep and semicircular to elongate in shape. They are a variety of sizes, generally closely situated to one another, separated by a small but thick lamina, and form a semi-circular spiralling pattern. The majority of complete osteoderms possess a slight, elongated keel (Figure 12). One complete osteoderm is preserved in ventral view, with a smooth and unornamented ventral surface (Fig. 12). The phalanges are of typical thalattosuchian shape, similar to *S. bollensis* (SMNS

51753; however, they are much larger (over 50%) than those seen in *S. bollensis*). There are possible stomach contents preserved on the ventral underside of the slab, located between the dorsal ribs.

Discussion: The distal end of the preserved coracoid in MNHNL TV209 is less mediolaterally flared in *S. bollensis* (SMNS 51753) and the shaft is noticeably thicker. It is similar to the right coracoid preserved in *P. multiscrobiculatus* (SMNS 9930; although in this specimen the coracoid is partially covered by the humerus). The dorsal ribs display a deep and proximodistally wide costal groove, similar to both *S. bollensis* (SMNS 51563) and *S. gracilirostris* (NHMUK PV OR 14792; although it is difficult to see in this specimen due to preservation). The vertebral centra are of typical teleosauroid shape, being taller than wide and mediolaterally constricted (hourglass-shaped), which is seen in *S. bollensis* (SMNS 51563), *S. gracilirostris* (NHMUK PV OR 14792) and *P. multiscrobiculatus* (SMNS 9930). The ornamentation on the dorsal osteoderms consists of irregular large pits, with varying degrees of closeness. This is similar to *S. bollensis* (SMNS 51953) and differs from *S. gracilirostris* (NHMUK PV OR 14792), in which the pits are slightly smaller and more subcircular in shape and *P. multiscrobiculatus* (SMNS 9930), where the ornamentation consists of small pits situated close to one another. Due to this combination of features, we cannot be certain of the species-level identity of MNHNL TV209 and conservatively assign it to Teleosauroidea indet.

TELEOSAUROIDEA INDET

Figure 13. Photograph of Teleosauroidea indeterminate, MNHNL TV481. The photograph of MNHNL TV481 was provided by R. Weis from the museum database, and no scale bar is present.

Material: a large slab consisting of articulated ventral osteoderms (MNHNL TV481).

Horizon and locality: *Harpoceras serpentinum* ammonite Zone ('*schistes bitumineux*'), Dudelange-Bettembourg, Luxembourg; Early Toarcian, Early Jurassic.

Description: MNHNL TV481 consists of four articulated rows of osteoderms in ventral view (Fig. 13). The surface of all osteoderms are smooth and unornamented.

Discussion: MNHNL TV481 is currently not located in the museum and is on exhibition at a small local museum in Bascharage, Luxembourg, accessible only on demand. Thus, it was examined only by photograph. The osteoderms of MNHNL TV481 have smooth and unaltered surfaces, similar to other teleosauroids (e.g. *S. bollensis* SMNS 53422; *S. leedsi,* NHMUK PV R 3806). They are larger in size than those seen in *P. typus* (MNHN.F RJN 463). Due to lack of clear species-level diagnostic features, we assign MNHNL TV481 to Teleosauroidea indet.

TELEOSAUROIDEA INDET

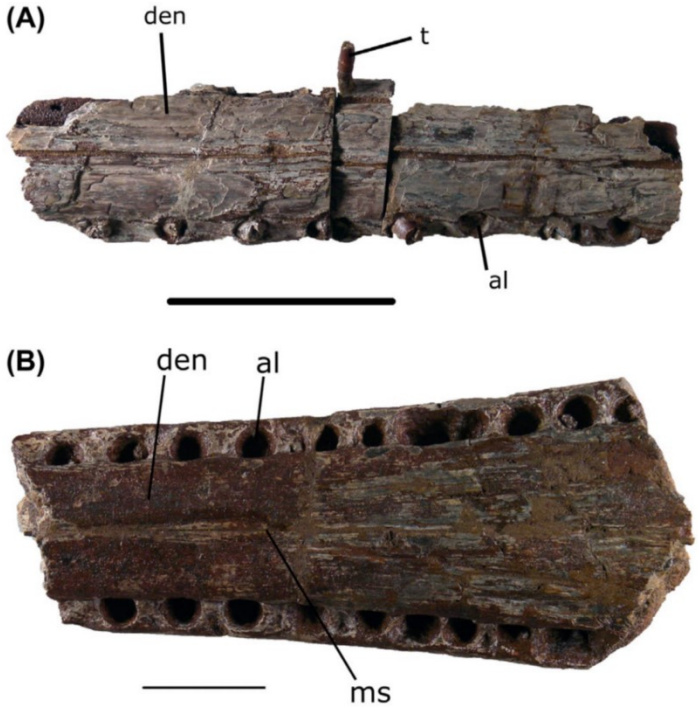


Figure 14. Photograph of section 1 (A) and section 2 (B) of Teleosauroidea indeterminate, MNHNL DOU351. Mandible in dorsal view. Refer to the main text for the abbreviations list. Scale bar: (A) 10 cm and (B) 3 cm.

Material: a partial lower jaw (MNHNL DOU351) composed of two sections.

Horizon and locality: *Dumortieria pseudoradiosa* ammonite Zone, Minette ironstone formation, '*Braunes Lager*' (Esch-sur- Alzette), Luxembourg; Late Toarcian, Early Jurassic.

Description: MNHNL DOU351 is an incomplete lower jaw of a teleosauroid, and is divided into two separate sections. The first part of MNHNL DOU351 (Fig. 14A) is composed of three pieces. They are made up of the dentaries, which are the major elements of the lateral and dorsal surfaces of the lower jaw. A well-developed midline suture (Andrews, 1913) connects the dentaries. There are eight dentary alveoli preserved on the left side and only one complete alveolus on the right (Fig. 14A), all of which are parallel to the midline suture. The alveoli are large, deep and subcircular, with a relatively large interalveolar distance (longer than the total alveolar width) (Fig. 14A). There are two teeth preserved in situ (one on the right side and one of the left side), both with the apex missing (Fig. 14A). They are conical in shape with a slight posterior curvature. The tooth preserved on the right side is bicarinate.

There are numerous faint, spaced apart enamel ridges running up the teeth (in apicobasal length), parallel to the carinae (this is better observed in the tooth on the right side). No serrations are preserved.

The second section of MNHNL DOU351 (Fig. 14B) consists of the posterior part of the dentary. There are nine and eleven alveoli preserved on the left and right sides, respectively. The alveoli are large and subcircular, parallel to the mandibular symphysis (in which the anterior and posterior areas are not preserved) and the interalveolar spacing is smaller than the first part of MNHNL DOU351, being less than half but larger than a quarter of the alveolar width. There is no evidence of posterior curvature. There are faint reception pits seen in dorsal view (Fig. 14B). The coronoid processes are not observed (although this could be due to preservation).

Discussion: While the middle dentaries of MNHNL DOU351 can be interpreted as either metriorhynchid or teleosauroid (as they are relatively similar; Andrews, 1913), the shape and interalveolar spacing of the alveoli are more representative of a teleosauroid than a metriorhynchid. The interalveolar spacing is relatively large, which is similar to *S. gracilirostris* (MNHNL TU515). The second section of MNHNL DOU351 has faint reception pits in the anterior region of the lateral dentaries. These are present in *S. brevior* (NHMUK PV OR 14781), whereas *S. gracilirostris* (NHMUK PV OR 14792, MNHNL TU515), *S. bollensis* (SMNS 51953) and *P. multiscrobiculatus* (SMNS 9930) lack them. Therefore, we assign MNHNL DOU351 to Teleosauroidea indet.

THALATTOSUCHIA INDET

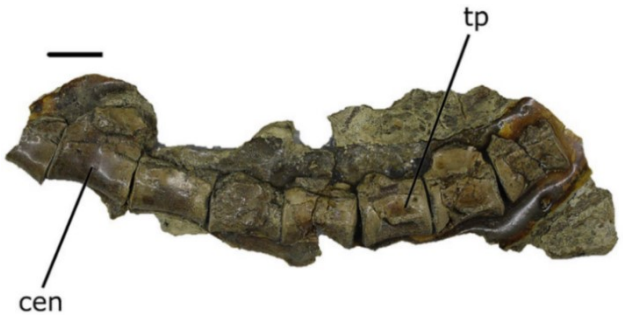


Figure 15. Photograph of Thalattosuchia indeterminate, MNHNL TU914 (previously referred to as *Teleosaurus minimus* (Quenstedt 1852)). Refer to the main text for the abbreviations list. Scale bar: 1 cm.

Material: articulated caudal vertebrae, seven complete and one partial (MNHNL TU914).

Horizon and locality: Unknown zone, lithology and locality.

Description: The centra and proximal transverse processes are preserved in right lateral view in MNHNL TU914, as the neural spines and majority of the transverse processes are missing. All centra (Fig. 15) are anteroposteriorly short and hourglass- shaped, which is typical in teleosauroid caudal vertebrae (Andrews, 1913). The centra are taller than wide and all are roughly 2.2 cm in anteroposterior length. The transverse processes are small, situated in the middle of the centrum and gradually disappear from anterior to posterior.

Discussion: MNHNL TU914 is labelled as *Teleosaurus minimus* Quenstedt, 1852, in the museum catalogue. As with MNHNL TU799, there is no record of supporting evidence for this taxonomic diagnosis (there is only a note stating that it was prepared on 21/05/96 by M. Marcel Schneider, by that time an employee and preparator at the MNHNL). It is now recognized that *T. minimus* is invalid as it is synonymous with small *S. bollensis* juveniles (Westphal, 1962). However, while the vertebrae of MNHNL TU914 are typical of teleosauroid caudal vertebrae (thin, hourglass shaped and taller than wide), there are no distinguishing features to classify it as *S. bollensis*. Indeed, it difficult to assign a genus to teleosauroid caudal vertebrae in general, as they are very similar among the teleosauroid taxa. The posterior

caudal vertebrae of teleosauroids are also similar in shape and size to those found in metriorhynchids and *Pelagosaurus typus*. Therefore, we assign MNHNL TU914 to Thalattosuchia indet.

THALATTOSUCHIA INDET

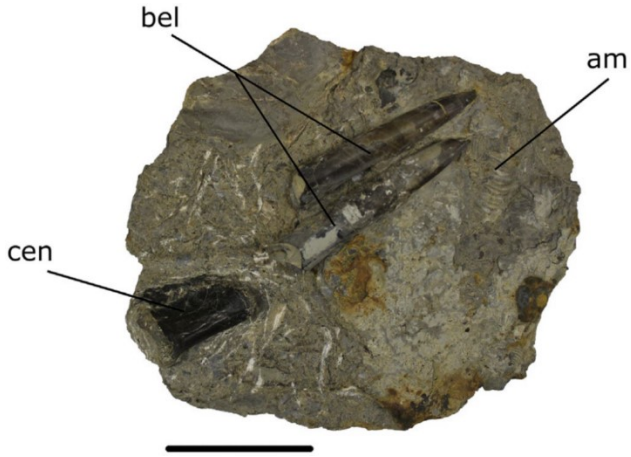


Figure 16. Photograph of Thalattosuchia indeterminate, MNHNL TV561. Note the two belemnites and ammonite impression. Refer to the main text for the abbreviations list. Scale bar: 1 cm.

Material: one partial caudal vertebra (MNHNL TV561).

Horizon and locality: *Hildoceras bifrons* ammonite Zone, Marnes à Bifrons, Sanem, Luxembourg; Early Toarcian, Early Jurassic.

Description: MNHN TV561 is of a centrum of one caudal vertebra (Fig. 16). It is of typical teleosauroid shape: mediolaterally constricted, taller than wide and strongly hourglass-shaped. It measures roughly 2 cm in anteroposterior length. The neural spine is not preserved and there is no evidence of a transverse process (the lateral surface of the centrum is smooth). There are invertebrates associated with this vertebra: two belemnites and an ammonite impression (Fig. 16).

Discussion: As mentioned above, MNHNL TV561 displays features typical of teleosauroid caudal vertebrae: (1) mediolaterally thin; (2) hourglass shaped; and (3) taller than wide. These are similar to other teleosauroids such as *S. bollensis* (SMNS 18699, SMNS 51753), *S. gracilirostris* (NHMUK PV OR 14972) and *P. multiscrobiculatus* (SMNS 9930), as well as the basal

metriorhynchoid *P. typus* (NHMUK PV R 6213, MNHN.F RJN 463). MNHNL TV561 is likely to be a posterior caudal vertebra, as it is quite small (only 2 cm anteroposterior length) and lacks a transverse process. We assign MNHNL TV561 to Thalattosuchia indet.

THALATTOSUCHIA INDET

Figure 17. Photograph of Thalattosuchia indeterminate, MNHNL TV597. Refer to the main text for the abbreviations list. Scale bar: 1 cm.

Material: two caudal vertebrae centra (MNHNL TV597) preserved on a rounded block of matrix.

Horizon and locality: *Harpoceras serpentinum* ammonite Zone ('*schistes bitumineux*'), Sanem, Luxembourg; Early Toarcian, Early Jurassic.

Description: Both centra (Fig. 17) are amphicoelous and of typical teleosauroid shape. They are mediolaterally thin, taller than wide, anteroposteriorly elongate and hourglass-shaped. The neural spines and transverse processes are not preserved.

Discussion: Both centra preserved in MNHNL TV597 are representative of a typical teleosauroid caudal vertebrae: mediolaterally constricted and thin, hourglass-shaped and taller than wide. This is similar to *S. gracilirostris* (NHMUK PV OR 14792), *S. bollensis* (SMNS 18699, SMNS 51753) and *P. multiscrobiculatus* (SMNS 9930), as well as the basal metriorhynchoid *P. typus* (NHMUK PV R 6213, MNHN.F RJN 463). Thus, we assign MNHNL TV597 to Thalattosuchia indet.

THALATTOSUCHIA INDET

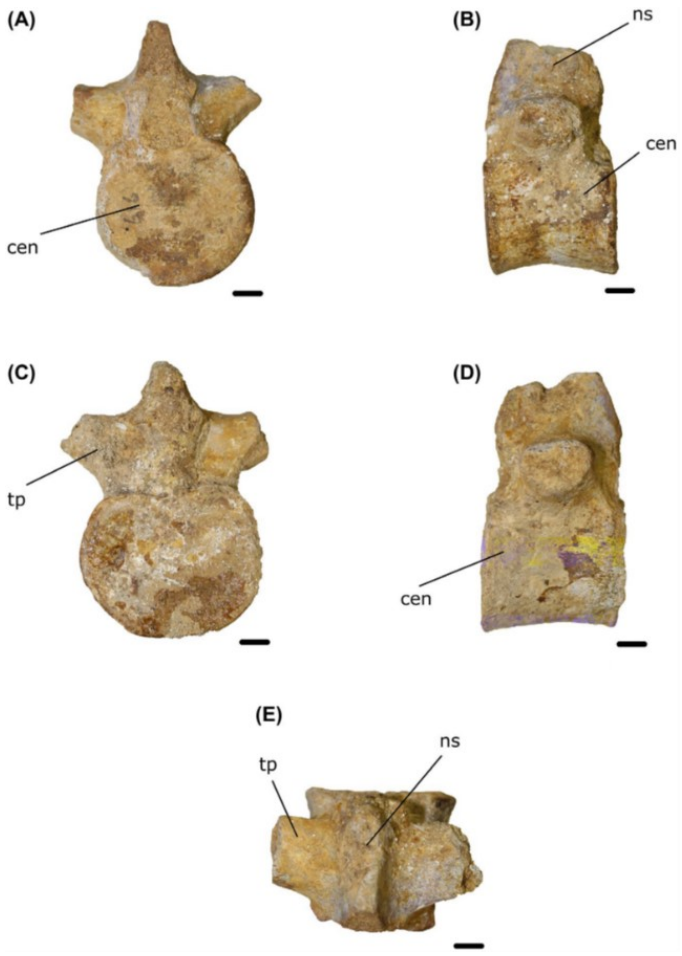


Figure 18. Photograph of Thalattosuchia indeterminate, MNHNL DOU725, in (A) anterior, (B) left lateral, (C) posterior, (D) right lateral and (E) dorsal views. Refer to the main text for the abbreviations list. Scale bar: 1 cm.

Material: a single centrum (MNHNL DOU725) of a caudal vertebra.

Horizon and locality: Unknown zone, Minette ironstone formation, Esch-sur-Alzette, Luxembourg; Late Toarcian, Early Jurassic.

Description: The centrum of the vertebra is faintly amphicoelous and slightly mediolaterally wider than dorsoventrally high (Fig. 18). The neural canal is dorsoventrally tall and oval shaped. In lateral view, the centra centrum is anteroposteriorly short and slightly circular (Fig. 18). The prezygapophyses and postzygapophyses are not preserved, nor are the distal transverse processes.

Discussion: MNHNL DOU725 is similar in shape to MNHNL TV602. The centrum of MNHNL DOU725 is slightly mediolaterally longer (wider than tall)

than those seen in a typical cervical or dorsal vertebra of a teleosauroid (e.g. *S. gracilirostris* NHMUK PV OR 14792; *S. bollensis* SMNS 51753), although it is possible for cervical vertebral centra to be wider than tall in teleosauroids, as mentioned above. The anteroposterior length of MNHNL DOU725 is relatively short and while the centra of sacral vertebrae are typically marginally wider than tall in teleosauroids (e.g. *S. bollensis* MMG BwJ 595, *S. edwardsi* NHMUK PV R 3701), the proximal part of the transverse processes in MNHNL DOU725 are more dorsally inclined than in other teleosauroids. We therefore assign MNHNL DOU725 to Thalattosuchia indet.

THALATTOSUCHIA INDET

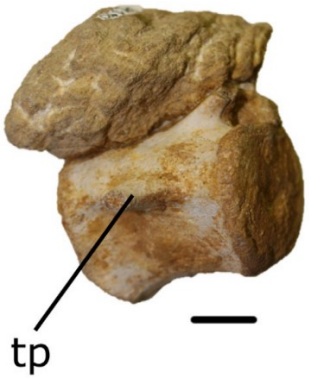


Figure 19. Photograph of Thalattosuchia indeterminate, MNHNL BM190. Note the mediolaterally and dorsoventrally thin transverse process. Refer to the main text for the abbreviations list. Scale bar: 1 cm.

Material: a single partially preserved vertebra (MNHNL BM190).

Horizon and locality: *Stephanoceras humphriesianum* ammonite Zone, '*Marnes sableuses d'Audun-le-Tiche*', Rumelange, Luxembourg; early Bajocian, Middle Jurassic.

Description: The vertebral centrum (Figure 19) is approximately 4.1 cm in length and is wider than tall. The anterior and posterior central surfaces are rounded and slightly amphicoelous. There is a flat, posteroventrally deflected surface on the ventral margin of the posterior surface (Fig. 19). The

transverse processes are small, anteroposteriorly thin and dorsoventrally flat (Fig. 19). There is a slight elongated concavity anteroventral to each transverse process.

Discussion: MNHNL BM190 is not of typical cervical, dorsal, sacral or caudal teleosauroid shape (such as *S. bollensis*, SMNS 51753), as it is more rounded and expanded mediolaterally. The transverse processes are also quite anteroposteriorly and dorsoventrally thin, much more so than *S. bollensis* (SMNS 51753), *S. gracilirostris* (NHMUK PV OR 14792) and *P. multiscrobiculatus* (SMNS 9930). Therefore, we tentatively assign MNHNL BM190 to Thalattosuchia indet.

PALAEODIVERSITY

The genus '*Steneosaurus*' is considered paraphyletic (Mueller- Töwe, 2006; Jouve, 2009; Young et al., 2014a; Wilberg, 2015a, 2015b) and is currently under revision (see Chapter VI). However, for the time being we retain use of this genus-level name, and regardless of the generic taxonomy, we can recognize two distinct species in Luxembourg: *Steneosaurus gracilirostris* (MNHNL TV515) and *Steneosaurus bollensis* (MNHNL TU164 and MNHNL TU799). There is also at least one representative of the species *Platysuchus multiscrobiculatus* (MNHNL TU895), recognized by its apomorphic number of five premaxillary teeth (Westphal, 1961, 1962), as mentioned before. Otherwise, this taxon is only known from the Toarcian of Germany, making MNHNL TU895 currently the only known representative found outside of Germany. Finally, MNHNL TU164 is possibly a representative of a new species, based on the unusual feature of three alveoli per premaxilla, although we require more specimens with this unique character to be certain whether it is diagnostic at the species-level. The presence of at least three, and possibly four, distinct teleosauroid species in the same locality during the Toarcian is an unusual phenomenon, rarely seen anywhere else (the Posidonienschiefer Formation in Germany would be another example, although it is significantly dominated by the taxon *S. bollensis*). Thus, the

Jurassic marine crocodylomorph fauna of Luxembourg was particularly diverse, with many species likely living together and filling different niches.

CONCLUSIONS

Luxembourg presents a wealth of fossil teleosauroids from the Early Jurassic, yet most have not been previously studied. Here we describe and figure 14 specimens (nine teleosauroids and five Thalattosuchia indeterminate) collected from southern Luxembourg, 13 of which are Toarcian in age. We conclude that there are at least two distinct genera (*Steneosaurus* and *Platysuchus*) and three distinct species (*S. gracilirostris*, *S. bollensis* and *P. multiscrobiculatus*) currently from Luxembourg, in addition to a possible fourth species (MNHNL TU164). The presence of four possible distinct teleosauroid species in the same location during the Toarcian is significant, as this is not observed elsewhere (with the Posidonienschiefer Formation in Germany being an exception). In addition, Luxembourg presents the only known occurrence of *P. multiscrobiculatus*, a very rare taxon, outside of Germany, as well as the only known appearance of a Toarcian teleosauroid with three premaxillary alveoli. These observations indicate that the Luxembourg thalattosuchian fauna, although comprised mostly of fragmentary specimens that have been little described in the literature, is a globally important assemblage for understanding the diversity and evolution of marine crocodylomorphs during the Age of Dinosaurs.

CHAPTER III:

Re-Description of Two Contemporaneous Mesorostrine Teleosauroids (Crocodylomorpha, Thalattosuchia) from the Bathonian of England, and Insights into the Early Evolution of Machimosaurini

"It is not the strongest of the species that survives, not the most intelligent that survives. It is the one that is the most adaptable to change."

- Charles Darwin

PREFACE: This chapter was published as Johnson et al. (2019), and is a result of collaboration between myself and my supervisors Stephen L. Brusatte and Mark T. Young. The majority of this paper, including the descriptions, comparisons, figures and conclusions, was my original work. I visited the OUMNH and accompanying museums to examine all the specimens included in the manuscript, took all the original photographs herein, and wrote and formatted the manuscript. Mark T. Young and Stephen L. Brusatte both provided thoughtful discussion, insight, and edited the manuscript.

INTRODUCTION

Teleosauroids (Thalattosuchia) were a group of distant extinct relatives of modern crocodiles that inhabited marine and brackish ecosystems throughout the Jurassic (Andrews, 1913; Buffetaut et al., 1981; Buffetaut, 1982; Hua, 1999; Foffa et al., 2015, 2019; Johnson et al., 2015, 2017, 2018; Martin et al., 2016) and Early Cretaceous (Fanti et al., 2016). This near-global group of ancient crocodylomorphs has often been regarded as the Jurassic marine equivalents of extant gavials, due to many species having an elongate and tubular snout, high tooth count and dorsally directed orbits, which is suggestive of a primarily piscivorous diet (Andrews, 1909, 1913; Buffetaut, 1982).

However, within Teleosauroidea the tribe Machimosaurini is characterized by blunt tooth crowns with serrated carinae and extensive enamel ornamentation, proportionally shorter snouts and lower tooth count, and proportionally anteroposteriorly and mediolaterally enlarged supratemporal fenestrae, all of which suggest a macrophagous–durophagous lifestyle (Eudes-Deslongchamps, 1864, 1867, 1869; Andrews, 1909, 1913; Buffetaut, 1982; Massare, 1987; Hua et al., 1994; Hua & Buffetaut, 1997; Vignaud, 1997; Martin & Vincent, 2013; Young et al., 2014a, 2014b, 2015a, 2015b; Fanti et al., 2016; Jouve et al., 2016; Johnson et al., 2017; Foffa et

al., 2018a). During the Middle Jurassic, machimosaurins were relatively rare compared to other teleosauroids, with isolated tooth crowns and indeterminate material known from the Bathonian of England, France and Morocco (Young et al., 2014a; Jouve et al., 2016), and *Lemmysuchus obtusidens* (Andrews, 1909) from the Callovian of England and France (Andrews, 1909, 1913; Young et al., 2016; Johnson et al., 2017). The Oxfordian is a poorly sampled stage for teleosauroids, but *L*. cf. *obtusidens* and *Machimosaurus* sp. are known from England and France, respectively (Young et al., 2014a; Foffa et al., 2015, 2018b). However, by the Kimmeridgian and Tithonian, multiple species of *Machimosaurus* are found across Europe (Sauvage & Liénard, 1879; Vignaud et al., 1993; Vignaud, 1995; Hua, 1996, 1999; Martin & Vincent, 2013; Young et al., 2014a, 2014b). At the end of the Kimmeridgian–earliest Tithonian, they had evolved into species adapted to living in high energy environments (*Machimosaurus mosae* Sauvage & Liénard, 1879: Hua, 1999; Young et al., 2014a) and others suited to life in open seas (*Machimosaurus hugii* von Meyer, 1837: Krebs, 1967; Young et al., 2014a).

Unfortunately, the machimosaurin material found from the Bathonian of Europe is poorly understood in terms of morphology, taxonomy and phylogenetics. While a handful of specimens from the Cornbrash Formation of England and Arromanches, France, were found and studied during the 19th and mid-20th centuries (see: De la Bêche & Conybeare, 1821; Eudes-Deslongchamps, 1866a, 1868a, 1868b; Eudes- Deslongchamps, 1867–69; Phillips, 1871; Phizackerely, 1951), few studies since have addressed them (e.g. Young et al., 2014a), due to few complete specimens and confusing taxonomic and phylogenetic issues.

Herein we review two historically important teleosauroid taxa comprising of near complete skulls housed in the Oxford University Museum of Natural History (OUMNH) from nearshore marine deposits of the Bathonian of England, provide detailed re-descriptions and establish two new genera. Using the latest phylogenetic analyses, we are able to test the relationships of these two new taxa in Teleosauroidea and show that

durophagous/macrophagous taxa were present during the Bathonian of the UK.

HISTORICAL BACKGROUND: '*STENEOSAURUS*' *LARTETI*

The taxonomic history of '*Steneosaurus*' *larteti* is convoluted. The holotype material comprises of a semi-complete skull, which was first named and described as *Teleosaurus larteti* sp. nov. by Jacques Amand Eudes-Deslongchamps (1866a). The holotype was named after Mr Lartet, "*notre grand paléontologiste français*" ["…our great French palaeontologist…"] (Eudes-Deslongchamps, 1867–69). The specimen (which also included a portion of the lower jaw, pelvis, hindlimb, two vertebrae and some dorsal osteoderms) was initially acquired by politician Mr Abel Vautier (when and how is unclear), which he then gave to J. A. Eudes-Deslongchamps, who had it prepared, presumably by Mr Stahl, the chief preparator (of which institution or university is not mentioned) (Eudes-Deslongchamps, 1867–69). The specimen was then reportedly stored in the collection of the Sorbonne Museum in Toulouse, France. Jacques A. Eudes- Deslongchamps (1868b) later changed the generic name to '*Steneosaurus*', but why he did so is unclear. His son Eugène Eudes-Deslongchamps (1867–69) re-described and re-figured the specimen in his famous *Notes Paléontologiques*. Eugène Eudes-Deslongchamps (1867–69) also briefly referred to specimens from both England and Germany (one of these is thought to be OUMNH J.29851) as '*S.*' *larteti*.

Phillips (1871) briefly referred to a handful of teleosauroid material (presumably including the English '*S.*' *larteti*) housed in the Oxford Museum (now known as the OUMNH) as *Teleosaurus brevidens* sp. nov., although he did not explicitly mention which specimen(s) he was referring to, and he made no mention of comparisons to the two Eudes-Deslongchamps' French specimens. Lydekker (1888) mentioned additional specimens from France and the UK, as pertaining to '*S.*' *larteti*, and Auer (1909) referred to a Callovian specimen (housed at the Eberhard Karls Universität Tübingen) as '*Steneosaurus*' *Larteti* var. Kokeni. Vignaud (1995) stated that the French

holotype described by J. A. Eudes-Deslongchamps (1866a) was eventually presumed destroyed during the bombing of Caen in 1944. During the mid-1900s, Phizackerely (1951) established a new species, '*S*.' *meretrix* (the naming controversy of '*S*.' *meretrix* will be discussed in the next section), referred OUMNH J.29851 (as well as several other Oxford specimens) to that species, and designated it as the paratype. Buffetaut & Thierry (1977) referred to a specimen, discovered by M. Détouillon, from Talant, France, as '*S*.' *larteti*, which comprised of a nearly complete skull and mandible, six vertebrae and an assortment of osteoderms. However, there is no reference as to where this specimen was, or is currently, housed. Young et al. (2014a) also figured and briefly referred to both OUMNH J.29850 and OUMNH J.29851 as '*S*.' *larteti*.

HISTORICAL BACKGROUND: '*STENEOSAURUS*' *BOUTILIERI*

1.1 *Early to mid-1800s,* Notes Paléontologiques *and the mystery of* Crocodilus oxoniensis

As with '*S*.' *larteti*, the history of '*S*.' *boutilieri* is complicated, but with perhaps a more confusing origin. De la Bêche & Conybeare (1821) mentioned the discovery of a partial crocodile skull from the Cornbrash Formation of Gibraltar, near Oxford. This skull was briefly mentioned again by Conybeare & Phillips (1822) and then largely neglected. It was not until E. Eudes-Deslongchamps' *Notes Paléontologiques* (1867–69) that this specimen was mentioned again. Eudes-Deslongchamps (1867–69: 230) stated "*…j'ai pu étudier, dans la collection d'anatomie compare du Muséum, un modèle en plâtre d'une tête presque complète avec sa mâchoire infé rieure, qui a été recueillie dans le cornbrash des environs d'Oxford (Angleterre). A cette pièce, portant sous le numéro de catalogue vm-2357 l'indication suivante,* Crocodilus oxoniensis *(Conybeare), était annexée une petite note pro bablement de la main de M. de Blainville et portant ces mots: «Trouvé près d'Oxford dans le calcaire oolithique dit cornbrash, donné par l'institution de Bristol, probablement une des espèces d'Honfleur»*" ["… I have been able to study, in the Museum's Comparative Anatomy Collection, a plaster model of

an almost complete head with its lower jaw, which has been collected in the Cornbrash of the neighbourhood [of] Oxford (England). To this piece, bearing under the catalogue number vm-2357, the following indication, *Crocodilus oxoniensis* (Conybeare), was attached, a small note probably by the hand of M. de Blainville and bearing these words: «Found near Oxford in oolitic limestone known as Cornbrash, given by the institution of Bristol, probably one of Honfleur's species»"]. In his monograph, E. Eudes-Deslongchamps (1867–69) disagreed with the naming of *C. oxoniensis*, claiming that he could not find any information pertaining to the description of this species, and that it was, therefore, invalid. Eudes-Deslongchamps (1867–69: 231) also stated the following about the *C. oxoniensis* 'holotype' (OUMNH J.1401): "…*c'est donc probablement un simple nom de catalogue donné dans une collection publique, et je pense que dans le cas où l'on viendrait à reconnaître que l'espèce des environs d'Oxford est la même que celle de Longues, on devrait les designer l'une et l'autre sous le nom de* Steneosaurus Boutilieri" ["…so it's probably a simple catalogue name given in a public collection, and I think that, in the event that we come to recognize that the species around Oxford is the same as that of Longues (area where the French '*S.*' *boutilieri* holotype was found), we should designate each under the name of *Steneosaurus Boutilieri*"].

Since De la Bêche & Conybeare (1821) never explicitly used the species '*oxoniensis*' in their work, it could be argued that it is not a valid species name, but rather one only present on specimen labels. According to Article 12.2.7 of the Code of the International Commission on Zoological Nomenclature (ICZN), when publishing names before 1931, "the proposal of a new genus-group name or of a new species-group name in association with an illustration of the taxon being named, or with a bibliographic reference to such an illustration, even if the illustration is contained in a work published before 1758, or in one that is not consistently binominal, or in one that has been suppressed by the Commission (unless the Commission has ruled that the work is to be treated as not having been published [Art. 8.7])" is perceived as valid. De la Bêche & Conybeare (1821) did not designate a new species, nor did they provide an indicative illustration or drawing of the crocodile skull from near Oxford; the name itself was only given on a

specimen label. Therefore, the name *C. oxoniensis* is not valid under the ICZN Code. Vignaud (1995: 186) mentioned that Eudes-Deslongchamps considered OUMNH J.1401 as "*appartenant à la même espèce*" ["belonging to the same species"] as the French holotype. Mr Boutillier, a former merchant who resided at Roncherolles, gave the holotype of '*S.*' *boutilieri* to the younger Eudes-Deslongchamps (when is unknown), as he had acquired this fossil from Mr Soemann, a man "*très intelligent, vient souvent dans nos pays récolter des fossiles pour le compte de son patron*" ["…very intelligent, often coming [to] our country to collect fossils on behalf of his boss…"] (Eudes-Deslongchamps 1866a: 121). When initially describing '*S.*' *boutilieri*, J. A. Eudes-Deslongchamps (1868a) incorporated material from both the French 'holotype' and OUMNH J.1401; E. Eudes-Deslongchamps (1867–69) also re-described '*S.*' *boutilieri* using these specimens. In addition, Woodward (1885) explicitly reported that the cast (OUMNH J.1401) in Oxford has the names of *C. oxoniensis* Conybeare and *S. oxoniensis* De la Beche. Woodward (1885: 501) also wrote that "Mr Edward Wilson, to whose kindness the writer is indebted for particulars of the Crocodilian fossils now in the Bristol Museum, is unable to discover any such label in the collection; and the present whereabouts of the original specimen seems to be unknown." Based on Woodward's (1885) comments, it appears as though the epithet '*oxoniensis*' was never formally published and thus is an invalid name (a *nomen nudum*).

1.2 *The late 1800s*

As mentioned previously, Phillips (1871) named and described a new species, *T. brevidens* Phillips, 1871, using teleosauroid material housed in the Oxford Museum (but he was unclear which exact specimen(s) he referred to). He mentioned these specimen(s) as being "observed in Stonesfield and some other places in the Great Oolite near Oxford, [as] Enslow Bridge and Kidlington" (Phillips 1871: 184). On pages 184 to 185, figured in Diagram No. XLII/fig. 1, Phillips (1871) described the teeth of *T. brevidens* as "rather short [teeth] …a little curved, uniformly striated, the striae growing more prominent toward the point and finer toward the base… [a] slight trace of bicarination on these teeth, near the apex, which is usually blunt…" and regarded these

features as among the defining characteristics of *T. brevidens* (Phillips appears to be referring to the anastomosing pattern that is characteristic of machimosaurin teeth). Presumably, Phillips (1871) was referring to OUMNH J.29850 and/ or OUMNH J.1403, as he referred to not only the teeth, but the skull and palatal material as well.

Hulke (1877) described and figured a new species in dorsal view, *Steneosaurus stephani* Hulke, 1877 (NHMUK PV OR 49126), also present in the Cornbrash Formation and found in Closworth, Dorsetshire by Mr Darell Stephens. Hulke (1877) compared it to the descriptions of '*S.*' *larteti*, '*S.*' *boutilieri* and *Steneosaurus megistorhynchus* Geoffroy, 1831 (emend. Eudes-Deslongchamps, 1866a), given by E. Eudes-Deslongchamps (1867–69). Interestingly, Hulke (1877: 29) also briefly referred to *S.* (*Crocodilus*) *oxoniensis* in his comparisons, and writes as if E. Eudes-Deslongchamps used the name as well ("… which M. Deslongchamps regards as the mature form of *Steneosaurus Oxoniensis*…"). However, as mentioned previously, E. Eudes-Deslongchamps (1867–69) did not find '*oxoniensis*' as valid and referred to it as *boutilieri*. However, we agree with Hulke (1877) and consider *S. stephani* to be a separate and distinct species (see Discussion).

1.3 *The 1900s to present day*

In the early 20th century, Watson (1911) briefly described the palatal view of *S. stephani* (NHMUK PV OR 49126), which was initially neglected by Hulke (1877). Watson (1911, No. 18: 3) stated: "Eudes-Deslongchamps figures a plaster cast of a skull [OUMNH J.1401] from the English Cornbrash which he identifies with his '*S.*' *boutilieri*. This skull consists almost entirely of rostrum and is hence rather difficult to compare with *S. stephani*: so far as corresponding portions of the two skulls occur, they agree, and it is probable that they belong to the same species. The Bristol Museum contains another copy of this cast, and I found there a cast of the back of a Steneosaur skull which may belong to it; it agrees closely with *S. stephani*, but as there is no real evidence that it belongs to the snout, I think it is preferable to keep the name stephani for the Closworth skull."

It was not until Phizackerley's (1951) short monograph on teleosauroid specimens from Oxford that '*S*.' *boutilieri*, *T*. *brevidens* or the De la Bêche & Conybeare specimen was one again examined in any detail. Phizackerely (1951: 1184) initially referred to OUMNH J.29850 as being the type specimen of *T*. *brevidens* (note that, in 1951, the specimen was housed in the Department of Zoology at Oxford, so the specimen number was 1639/1; when it was moved to the Earth Sciences collection in the museum and given its current specimen number is unknown). Curiously, Phizackerley (1951: 1185) then stated that type material of *T*. *brevidens* was inaccessible, but then used 1639/1 (OUMNH J.29850) as the type specimen of his new species '*S*.' *meretrix*. This odd situation means that the type specimen of '*S*.' *meretrix* was already the type specimen of *T*. *brevidens*, thus making them objective synonyms. Thus, both *T*. *brevidens* and '*S*.' *meretrix* are considered as junior synonyms of '*S*.' *boutilieri*.

Steel (1973) and Vignaud (1995, 1997) referred to OUMNH J.1401 (the '*oxoniensis*' skull) and the *T*. *brevidens*/'*S*.' *meretrix* holotype (OUMNH J.29850) as '*S*.' *boutilieri*, although Vignaud (1997) referred to OUMNH J.1401 as *C*. *oxoniensis*. Godefroit et al. (1996) also briefly mentions E. Eudes-Deslongchamps' (1867– 69) holotype of '*S*.' *boutilieri* [as well as Phizackerley's (1951) work on the aforementioned Oxford specimens and Hulke's (1877) *S. stephani*] in comparison with a new specimen of *S*. *megistorhynchus*. Vignaud (1998) also highlighted the characteristic robust shape of the teeth seen in '*S*.' *boutilieri*.

GEOLOGY

The Great Oolite Group (GOG) is a Middle Jurassic (Bathonian) lithostratigraphic unit that is well known from extensive exposures in central England, UK. The GOG consists of three formations that are, from youngest to oldest, the Cornbrash Formation, the Forest Marble Formation and the White Limestone Formation (Palmer & Jenkyns, 1975; Sellwood et al., 1985). Both the Forest Marble Formation and the White Limestone Formation were primarily deposited by laterally migrating tidal channels in an intertidal

environment (Klein, 1963, 1965; Palmer & Jenkyns, 1975). Several important fossils are known from the GOG, including pterosaurs (O'Sullivan & Martill, 2018), crocodylomorphs (De la Bêche & Conybeare, 1821; Eudes-Deslongchamps, 1867–69), dinosaur remains (Woodward, 1910; Benson, 2010) and reptilian eggs (Buckman, 1860).

The Cornbrash Formation (CF) is a Bathonian–Callovian (Middle Jurassic) lithostratigraphic unit that underlies the Oxford Clay Formation (OCF; Wright, 1977). This stratigraphic section consists of medium- to fine-grained limestone that is bioturbated, yields some reptilian (Hulke, 1877; Benton & Spencer, 1995) and many trace fossils (e.g. Powell & Riding, 2016), and stretches from the Weymouth area to the Scarborough area in the UK (Cox & Sumbler, 2002), similar to the OCF. The CF is comprised of two main units (the Cornbrash Limestone and the Cornbrash Shales), which form a transgressional marine cycle and mark the first marine invasion of the Jurassic delta subsequent to that represented by the Middle Bajocian Scarborough Beds (Wright, 1977). The CF in England is also correlative with '*Fuller's Earth inférieur*' in France (see: Vignaud, 1995). All currently known English specimens of '*S*.' *boutilieri* (e.g. OUMNH J.1401, OUMNH J.29850) and '*S*.' *larteti* (OUMNH J.29851) were found in the CF.

The area of Arromanches is located near the northern coast of France and has several localities in which Jurassic rocks are exposed (De la Bêche, 1822). One particular rock unit is the Caen Limestone, which dates back to the Early to Middle Bathonian (Rioult, 1961; Fily, 1978) and represents a shallow lagoonal environment. The Caen Limestone includes *Zigzagiceras zigzag* d'Orbigny, 1846, *Asphinctites tenuiplicatus* Brauns, 1865 and *Procerites progracilis* (Cox & Arkell, 1950) ammonite zones from the Early to Middle Bathonian (O'Dogherty et al., 2000; Sandoval et al., 2001; Moyne & Neige, 2007), and is represented by fossils of crocodylomorphs (Eudes-Deslongchamps, 1867–69) and multiple invertebrates (e.g. Lyell, 1840; Pavia et al., 2013). A second locality is Longues-sur-Mer (Calvados, Normandy), which includes sections of Bathonian oolitic sandstones and limestones (De la Bêche, 1822; Benabdellouahed et al., 2014). These oolitic sediments include the *Oxycerites* cf. *orbis* (Giebel, 1852) and *Clydoniceras discus*

(Sowerby, 1813) ammonite zones from the Middle to Late Bathonian (Sandoval et al., 2001; Roy et al., 2007; Scheck-Wenderoth et al., 2008). It is near Longues-sur-Mer that the holotype of '*S*.' *boutilieri* was presumably collected (Eudes-Deslongchamps, 1867–69), at the "*sommet de la Grande Oolithe*" ("summit of the Great Oolite") in the *Oxycerites* cf. *orbis* or *Clydoniceras discus* ammonite zones (Vignaud, 1995). The holotype of '*S*.' *larteti* came from the '*Calcaire de Caen ou* [or] *Fuller's earth inférieur*' in either the *Zigzagiceras zigzag*, *Asphinctites tenuiplicatus* or *Procerites progracilis* ammonite zones (Eudes-Deslongchamps, 1867–69; Vignaud, 1995).

ABBREVIATIONS

Institutional: CAMSM, Sedgewick Museum, Cambridge, UK; IRSNB, Institut Royal des Sciences Naturelles de Bruxelles, Brussels, Belgium; GPIT, Paläontologische Sammlung der Eberhard Karls Universität, Tübingen, Germany; IVPP, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; LPP (PALEVOPRIM-CVCU), Institut de paléoprimatologie, paléontologie, humaine; évolution et paléoenvironnements Université de Poitiers, Poitiers, France; MG, Museu Geológico, Lisbon, Portugal; MHNM, Muséum d'Histoire Naturelle de Marrakech, Morocco; MNHN, Muséum national d'histoire naturelle, Paris, France; MNHNL, Musée national d'histoire naturelle, Luxembourg; MMG, Staatliches Museum für Mineralogie und Geologie, Dresden, Germany; NHMUK, Natural History Museum, London, UK; NOTNH, Nottingham Natural History Museum, Nottingham, UK; ONM, Musée de l'Office National Des Mines, Tunis, Tunisia; OUMNH, Oxford University Museum of Natural History, Oxford, UK;. PETMG, Peterborough Museum and Art Gallery, Peterborough, UK; SMNS, Staatliches Museum für Naturkunde Stuttgart, Baden-Württemberg, Germany.

Anatomical: an, angular; anas, anastomosing pattern; antorb f, antorbital fenestra; art, articular; basiocc, basioccipital;?basisph, possible basisphenoid; basisph, basisphenoid; car, carina; cnXII, cranial nerve XII; cor, coranoid; cor gr, coronoid groove; D4, fourth dentary alveolus; D16,

sixteenth dentary alveolus; den, dentary; dor o, dorsal osteoderm; ectopt, ectopterygoid; exocc, exoccipital-opisthotic; f, frontal; f m, foramen magnum;?j, possible jugal; j, jugal; l, lacrimal; Mec gr, Meckelian groove; M1, first maxillary alveolus; M12, twelfth maxillary alveolus; M16, sixteenth maxillary alveolus; M18, eighteenth maxillary alveolus; mx, maxilla; n, nasal; P3, third premaxillary alveolus; occ con, occipital condyle; orb, orbit; p, parietal; pal, palatine; pmx, premaxilla; porb, postorbital; prf, prefrontal; pt, pterygoid; q, quadrate; qj, quadratojugal; rec p, reception pit; retro art, retroarticular process; spl, splenial; sq, squamosal; subor, suborbital fenestra; supraocc, supraoccipital, sur, surangular.

SYSTEMATIC PALAEONTOLOGY

Crocodylomorpha hay, 1930 (sensu Nesbitt, 2011)

Thalattosuchia Fraas, 1901 (sensu Young & Andrade, 2009)

Teleosauroidea Geoffroy Saint-Hilaire, 1831 (sensu Young & Andrade, 2009)

Deslongchampsina M. M. Johnson, M. T. Young & S. L. Brusatte, **gen. nov.**

Type species: *Teleosaurus larteti* Eudes-Deslongchamps, 1866a (following recommendation 67B of the ICZN Code). Now referred to as *Deslongchampsina larteti* (J. A. Eudes-Deslongchamps, 1866a), **comb. nov.** urn:lsid:zoobank.org:act:B386203F-0945-4302-A3A6-1AF7D54674C5

Diagnosis: Same as the only known species (monotypic genus).

Etymology: Named in honour of Jacques Amand and Eugène Eudes-Deslongchamps, father and son French naturalists who thoroughly described the holotype specimen (in addition to numerous other teleosauroid taxa during the latter 1800s).

Deslongchampsina larteti (J. A. Eudes- Deslongchamps, 1866), **comb. nov,**

(Fig. 1)

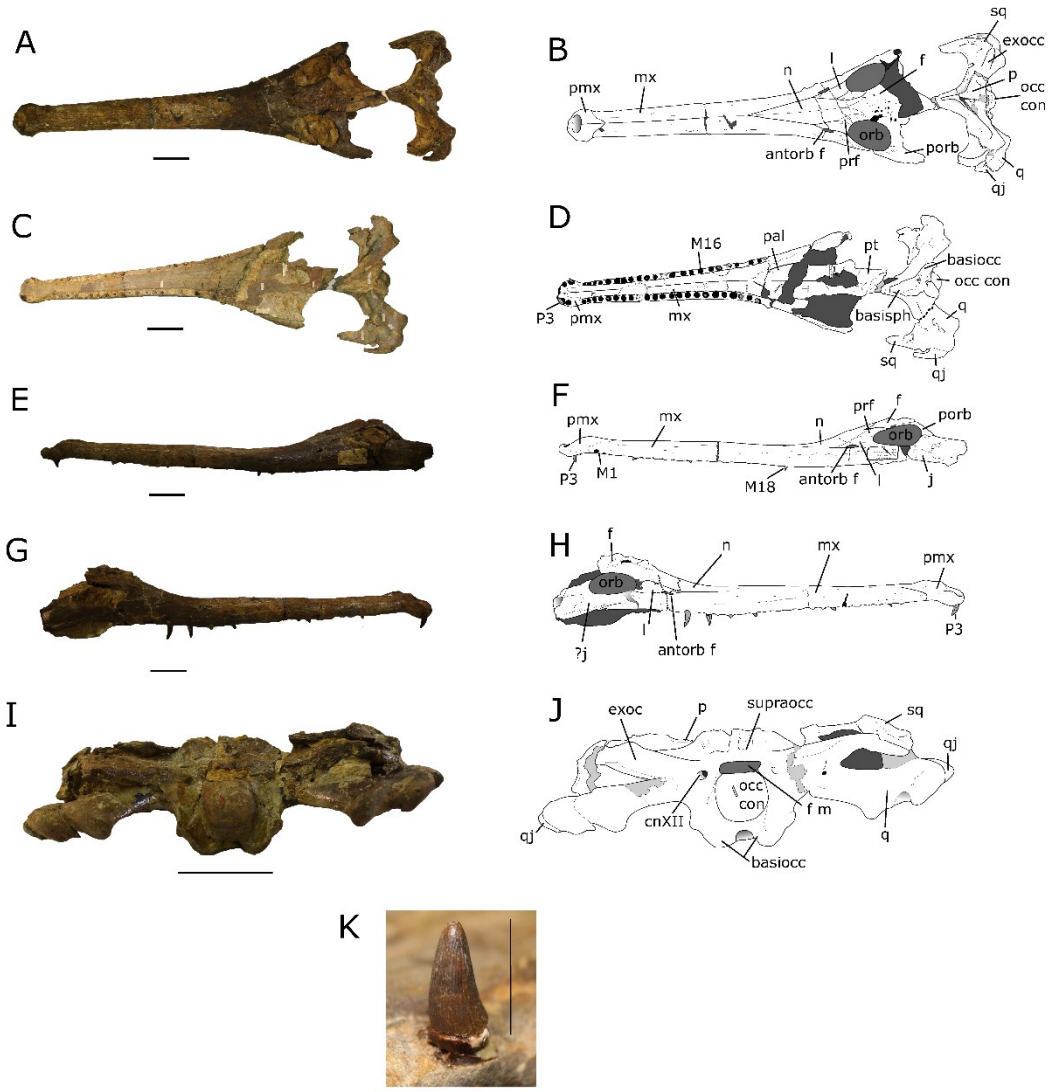


Figure 1. Photographs (A, C, E, G, I, K) and line drawings (B, D, F, H, J) of *Deslongchampsia larteti* (Eudes-Deslongchamps, 1866) **comb. nov.**, OUMNH J.29851, neotype. Skull in dorsal (A-B), palatal (C-D), left (E-F) and right (G-H) lateral, and occipital (I-J) views. Tooth of left P3 in right anterolabial (K) view. Darker shading represents matrix. Note the large antorbital fenestrae. Refer to the main text for the abbreviations list. Scale bars: 5 cm (A, C, E, G, I) and 3 cm (K).

v 1866a *Teleosaurus larteti* sp. nov.; J. A. Eudes- Deslongchamps, pp. 80–85, pl. 5 fig. 6.

v 1868b *Steneosaurus larteti* (Deslongchamps) comb. nov., J. A. Eudes-Deslongchamps, p. 124.

v 1867–69 *Steneosaurus larteti* (Deslongchamps); E. Eudes-Deslongchamps, p. 202, pl. 14, Figs. 1–4.

v 1870 *Steneosaurus larteti* (Deslongchamps); E. Eudes-Deslongchamps, p. 325, pl. 4, Figs. 1–4.

Vp. 1871 *Teleosaurus brevidens* sp. nov.; Philips, p. 186.

v 1875 *Steneosaurus larteti* (Deslongchamps); Huxley, p. 436, pl. 19.

(?) 1888 '*Steneosaurus*' de Parmilieu; Larrazet, pp. 8–15, pls 1–2.

v 1888 *Steneosaurus larteti* (Deslongchamps); Lydekker, p. 114.

1909 *Steneosaurus larteti* var. *kokeni* nov. var.; Auer, p. 256, pls 22-23.

1914 *Steneosaurus larteti* (sic) (Deslongchamps); Dreverman, pp. 42–43, fig. 5.

v 1936 *Steneosaurus larteti* (Deslongchamps); Kuhn, p.36.

v 1951 *Steneosaurus meretrix* sp. nov.; Phizackerley, pp. 1185–1187, Figs. 4–6.

v 1962 *Steneosaurus larteti* (Deslongchamps); Krebs, p. 15.

v 1973 *Steneosaurus larteti* (Deslongchamps); Steel, p. 31.

v 1977 *Steneosaurus larteti* (Deslongchamps); Buffetaut & Thierry, p. 158, fig. 3.

v 1982 *Steneosaurus larteti* (Deslongchamps); Buffetaut, p. 20.

v 1995 *Steneosaurus larteti* (Deslongchamps); Vignaud, pp. 187–188, pl. 3.

v 1996 *Steneosaurus larteti* (Deslongchamps); Godefroit et al., p. 98.

1998 *Steneosaurus larteti* (Deslongchamps); Mazin et al.

v 1998 *Steneosaurus larteti* (Deslongchamps); Vignaud, pp. 22–23.

v 2014 *Steneosaurus larteti* (Deslongchamps); Young et al., p. 3.

Holotype: A partial skull that was associated with a partial symphyseal section of the mandible, pelvis, hindlimb, two vertebrae (position in the axial skeleton unknown) and various dorsal osteoderms. Destroyed in 1944.

Holotype locality and horizon: '*Fuller's Earth inférieur*', Calvados, France. Bathonian, Middle Jurassic.

Neotype: OUMNH J.29851, comprising a partial skull, broken into two pieces.

Designation of neotype: Herein we formally designate OUMNH J.29851 as the neotype of *D. larteti*. In order to be in full accordance of Article 75 of the ICZN Code, in particular Article 75.3, we make the following statements:

1. This designation is made with the express purpose of clarifying the taxonomic status of *D. larteti*.
2. Our statement of the characters that we regard as differentiating *D. larteti* from other taxa is given by the species diagnosis below.
3. The neotype can be recognized through both the description below and Fig. 1.
4. The holotype is presumed destroyed in 1944 during the bombing of Caen.
5. The holotype had a partial skull; the description and figure given by J. A. Eudes-Deslongchamps (1866a) show it was a gracile, mesorostrine skull with rounded (little constricted) premaxillae, oval orbits, large antorbital fenestrae, robust and pointed teeth and slight but noticeable ornamentation. As such, the neotype is consistent with what is known of the former name-bearing type.
6. Unfortunately, the neotype is not from the same locality or country as the holotype. However, both types are from the same age (Bathonian) and relative formation (the CF in England is correlative with '*Fuller's Earth inférieur*' in France), and have both been referred to as the same species (see Historical Background).

7. The neotype is the property of a recognized scientific institution, OUMNH, which maintains a research collection with proper facilities for preserving name-bearing types, and is accessible for study.

Neotype locality and horizon: Cornbrash Formation, Great Oolite Group, Enslow Bridge, UK.

Etymology: Named after Mr Lartet, who gave the holotype to J. A. Eudes-Deslongchamps to study.

Emended diagnosis: Teleosauroid crocodylomorph with the following unique combination of characters among teleosauroids (autapomorphic characters indicated by an asterisk *): mesorostrine snout (rostrum under 68% of total skull length) (shared with '*Steneosaurus brevior*' Blake, 1876 (Sachs et al., in press), the Chinese teleosauroid previously referred to as *Peipehsuchus* [Li, 1993] IVPP V 10098, *Steneosaurus edwardsi* Eudes-Deslongchamps, 1868c and Machimosaurini); faint constriction of the premaxillae posterior to the external nares, giving the premaxillae a rounded, 'globular' appearance*; mediolaterally thin posterior processes of the nasals*; gradual and well-developed anteroventral sloping of the nasals*; presence of large, elongated antorbital fenestrae and internal antorbital fenestra between 25–50% of the length of the orbit (shared with *Steneosaurus gracilirostris* Westphal, 1961 and similar to '*S. brevior*'); frontal width subequal with orbital width (shared with the Chinese teleosauroid IVPP V 10098, *Mycterosuchus nasutus* Andrews, 1913, *Steneosaurus heberti* Morel de Glasville, 1876, *Y. boutilieri*, *Machimosaurus hugii* von Meyer, 1837 (emend. von Meyer, 1838) and *Machimosaurus rex* Fanti et al., 2016); small basioccipital tuberosities (similar to *Bathysuchus megarhinus* Hulke, 1871; Foffa et al., 2019); palatine anterior margin terminates level to 21st maxillary alveoli, or more distal alveoli (shared with *Steneosaurus leedsi* Andrews, 1909, *Myc. nasutus* and *B. megarhinus*); four premaxillary alveoli; large, robust, non-compressed teeth with a pointed apex and high relief enamel ridges (similar to *S. edwardsi*).

Description

A partial skull, broken into two pieces (rostrum and occipital), is the neotype of *D. larteti* (Fig. 1). The specimen is slightly dorsoventrally crushed in the anterior premaxillae and postorbital areas, but is overall relatively well preserved. The two pieces do not fit together exactly, as there is a small anterior part of the occipital piece not preserved. The skull is approximately 51 cm long from the anterior-most tip of the rostrum to the anterior margin of the orbits.

Premaxillae: The premaxillae (Fig. 1A–H) are relatively large and robust, surrounding the external narial opening. The external nares are oriented anterodorsally, laterally expanded and their posterior margins do not reach beyond the third premaxillary alveolar pair. Situated laterally to the external nares, there are a few shallow, circular foramina. The anterior two-thirds of the premaxilla is anteroposteriorly shortened and the anterior margin is ventrally deflected [giving the snout a scoop-like appearance, although not as pronounced as in *Mycterosuchus* (NHMUK PV R 2617) or an unnumbered LPP *Bathysuchus* specimen]. In dorsal view, the premaxilla–maxilla suture is subcircular and slightly interdigitating (Fig. 1A–B). There is very little constriction of the premaxillae posterior to the external nares (Figs. 1A–B, 3), which is not influenced by the slight dorsoventral crushing of the premaxillae. Due to this lack of constriction, the premaxillae appear almost globular in dorsal and ventral views, which differs from other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806; *Steneosaurus bollensis* Jäger, 1828 SMNS 51563, MMG BwJ 565; *Machimosaurus buffetauti* Young et al., 2015 SMNS 91415). In ventral view, the incisive foramen (=naso-oral fenestra) is relatively large and subcircular, and is situated in the middle of the suture of the premaxillae. There are four alveoli present (Fig. 1C–D), similar to most teleosauroids (e.g. '*S. brevior*' NHMUK PV OR 14781; *S. leedsi* NHMUK PV R 3806; *S. edwardsi* NHMUK PV R 3701) but different from *Platysuchus multiscrobiculatus* (Berckhemer, 1929) Westphal, 1961, Bathysuchus (which both have five) and *Machimosaurus* species (which have three). The first two alveoli are nearly confluent with a thin interalveolar lamina separating them. Both premaxillae are ornamented with conspicuous grooves on the external surfaces (Fig. 1A–B, E–H).

Maxillae: The maxillae (Fig. 1A–H) form a substantial part of the rostrum: they are elongate, transversely narrow, anteriorly separated by the premaxillae and their lateral margins are subparallel in dorsal view. The nasals are separated from the premaxillae by the maxillae. In dorsal and lateral views, the maxilla is ornamented with a few small pits and more numerous, larger grooves (Figs.. 1A–B, E–H). In addition, there is a parallel line of medium-sized, semicircular foramina dorsal to the maxillary ventral margin (Fig. 1E–H), similar to *S. edwardsi* (PETMG R178, NHMUK PV 2865) and *S. leedsi* (NHMUK PV R 3806), and differing from machimosaurins (which have two lines of foramina). The precise maxillary tooth count is difficult to determine, but there are at least 27 alveolar pairs, with the maxillary alveoli being very large and circular to subcircular in shape. The first maxillary alveolus is slightly laterally oriented, best seen in left lateral view (Fig. 1E–F); the positioning of this alveolus does not appear to have been influenced by dorsoventral crushing. The maxillary tooth row ends anterior to the anterior-most border of the suborbital fenestra. Reception pits for the dentary teeth are deep in the anterior portion of the maxilla but disappear when progressing posteriorly, similar to *S. edwardsi* (NHMUK PV R 2865, PETMG R178) and *S. heberti* (MNHN.F 1890- 13). In ventral view (Fig. 1C–D), the maxilla is smooth and unornamented, and the palatal processes meet in the midline expanding anteriorly and posteriorly. The maxilla forms the anterolateral margin of the suborbital fenestra (seen only in the anterior right; Fig. 1C–D). Faint palatal canals are also present laterally to the midline suture.

Jugals: The jugals (Fig. 1E–H) are triradiate and form the lateral border of the orbit, as in other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806; *S. bollensis* GPIT-RE-9425, SMNS 51957; the Chinese teleosauroid IVPP V 10098; *L. obtusidens* NHMUK PV R 3168). The left anterior jugal is covered by a specimen label (Fig. 1E). The postorbital–jugal contact (best seen in right lateral view) appears to be anteroposteriorly straight (Fig. 1G–H). It is difficult to discern the right maxillojugal contact due to a couple of large cracks in the area (Fig. 1G–H), but the anterior jugal does not extend anteriorly past the orbits as in *L. obtusidens* (NHMUK PV R 3168, PETMG

R39) or *S. edwardsi* (PETMG R178). The posterior parts of both jugals are not preserved and the quadratojugal–jugal contact is not seen.

Nasals: The large, triangular nasals (Fig. 1A–B, E–H) are exposed on the dorsal surface of the posterior rostrum and orbital area. The anterior nasals are mediolaterally narrow and the lateral margins are strongly confluent. The nasal anterior processes are approximately one-third of the posterior area of the rostrum and have a well-developed near-parallel sutural contact with the maxillae. The nasals also have a strongly interdigitating contact with both the prefrontals and frontal. The posterior processes of the nasals are mediolaterally thin and are constricted by the prefrontals and frontal (Fig. 1A–B) relative to other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806; *S. bollensis* SMNS 20283, SMNS 51563). There is a slight yet noticeable midline concavity (‘midline trench’) and a well-developed internarial suture (especially in the posterior region), suggesting that the nasals are unfused (differing from *L. obtusidens* NHMUK PV R 3168). In lateral view, the posterior nasals have a well-developed, gradual anteroventral ‘slope’ (Fig. 1E–H), differing from the abrupt ‘dome’ seen in *L. obtusidens* (e.g. NHMUK PV R 3168, NOTNH FS3361).

Prefrontals: The prefrontals (Fig. 1A–B, E–H) are subtriangular in shape and longer than wide in dorsal view. The prefrontal forms the anteromedial border of the orbits and contacts the nasal and frontal medially and the lacrimal laterally (Fig. 1A–B, E–H). The prefrontal–lacrimal contact is relatively straight and the prefrontal–frontal contact is irregular. The dorsal surfaces of the prefrontals are ornamented with a few medium-sized pits and grooves.

Lacrimals: The lacrimals are large, triangularshaped bones that can be seen in both dorsal and lateral views (Fig. 1A–B, E–H), similar to other teleosauroid taxa (e.g. *S. leedsi* NHMUK PV R 3806; *S. bollensis* SMNS 51563; *S. gracilirostris* NHMUK PV OR 14792; *Myc. nasutus* NHMUK PV R 2617). The lacrimal broadly contacts the nasal and constitutes the anterolateral border of the orbits and the anterior margin of the antorbital fenestra (Fig. 1A–B, E–H). The antorbital fenestrae are large, anteroposteriorly elongated and slightly oval-shaped (Fig. 1A–B, E–H), similar to those in *S. gracilirostris* (NHMUK PV OR 14792) and differing from

the small, subcircular antorbital fenestrae seen in other teleosauroids (e.g. *Myc. nasutus* NHMUK PV R 2617; *S. leedsi* NHMUK PV R 3806; the Chinese teleosauroid IVPP V 10098) (Fig. 11). The antorbital fenestrae are nearly a quarter of the anteroposterior orbital length (24%), similar to '*S. brevior*' (27%) (NHMUK PV OR 14781) and similar in design, but not to the same extent, as in *S. gracilirostris* (which is approximately 57%) (NHMUK PV OR 14792). Other teleosauroids with antorbital fenestrae range from between 11% (e.g. *Myc. nasutus* NHMUK PV R 2617) and 16% (e.g. *S. leedsi* NHMUK PV R 3806).

Frontal: The frontal (Fig. 1A–B) is a single, dorsoventrally deep bone with no evidence of a midline suture. The frontal forms a relatively straight vertical contact with the postorbital in dorsal and lateral views, forms the anterior medial borders of the supratemporal fenestrae and contributes to the posteromedial border of the orbits (Fig. 1A–B), which are large and suboval in shape. The anterior process is relatively long and slender, proceeding further anteriorly than the anterior margin of the orbits, as in the majority of other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3320; *S. edwardsi* PETMG R178), but differing from *S. stephani* NHMUK PV OR 49126 (where the anterior process is relatively short and mediolaterally broad). The frontal dorsal surface is ornamented with pits that are restricted to the centre of the bone, and grooves that extend towards the lateral-most edges of the bone.

Postorbitals: Only the left postorbital is preserved (Fig. 1A–B, E–F). It is a broad, heavy bone and reaches the orbit posteroventral margin, where it overlaps with the jugal. The postorbital forms the lateral and posteroventral margins of the supratemporal fenestra, as well as the posterior margin of the orbit, with the overall body being anteroposteriorly broadened (Fig. 1E–F). The postorbital bar (formed by the frontal– postorbital contact) is similar to other teleosauroids (e.g. *S. bollensis* SMNS 51753; *S. edwardsi* NHMUK PV R 3701; *L. obtusidens* LPP.M.21). It is slightly anteroposteriorly thickened and has small, sparse pits for ornamentation in the medial part. The postorbital– squamosal contact is not preserved. While the specimen is broken into two pieces (see above) near the middle of the supratemporal

fenestrae, they appear to be anteroposteriorly elongated and rectangular in shape (Fig. 1A–B).

Parietal: The single parietal is a relatively large, mediolaterally thickened bone (Fig. 1A–B), and has shallow dorsal ornamentation consisting of a few irregular pits. The anterior-most end of the parietal is not preserved (Fig. 1A–B). The parietal contributes to the posterior and medial borders of the supratemporal fenestrae and does not overhang the occiput in dorsal view (Fig. 1I–J).

Squamosals: The majority of the squamosals (Fig. 1A–B) are not preserved, but they are elongated L-shaped bones similar to those seen in other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806; *S. edwardsi* PETMG R178; *Mac. buffetauti* SMNS 91415). The anterior process is anteroposteriorly elongated (in dorsal view) and forms the posterolateral border of the supratemporal fenestrae. The posterolateral surface of the squamosal is concave in lateral view and convex in dorsal view (Fig. 1A–B). The squamosal bar is well-developed and contacts the postorbital bar anteriorly; together these two bones form the supratemporal arch, which is sparsely ornamented.

Quadrates: The quadrates (Fig. 1A–D, I–J) are of substantial size and are strongly sutured to the squamosals and quadratojugals. The anterodorsal region of the quadrate contacts the squamosal and quadratojugal, and medially contacts the exoccipital– opisthotic. Both hemicondyles are mediolaterally elongated (oval-shaped) with rounded posterior edges, as seen in other teleosauroids (e.g. *S. edwardsi* PETMG R178; *S. heberti* MNHN.F 1890-13). The posteroventral medial hemicondyle is approximately the same in size and mediolateral length as the lateral hemicondyle, differing from *Mac. hugii* (MG-8730–2). On the occiput, the hemicondyles posteriorly extend slightly further than the exoccipital–opisthotic (Fig. 1I–J). The anterior-most quadrates are not preserved.

Quadratojugals: The posterior-most part of the quadratojugals is best preserved on the left side (Fig. 1C–D, I–J); the posterior region is expanded

mediolaterally to accommodate the quadrate. Neither of the quadratojugals is visible in dorsal view.

Supraoccipital: The supraoccipital (Fig. 1I–J) is ventral to the parietal and only visible in occipital view. It is a single bone that forms the dorsomedial part of the occiput and contributes to the dorsal edge of the foramen magnum (Fig. 1I–J), as in all teleosauroids (e.g. *S. gracilirostris* MNHNL TU515; *S. leedsi* NHMUK PV R 3806; *S. heberti* MNHN.F 1890-13; *L. obtusidens* LPP.M.21). A moderate nuchal crest is present, smaller than that seen in *S. gracilirostris* (MNHNL TU515). The supraoccipital is dorsoventrally tall (although it is slightly dorsally crushed), mediolaterally expanded and slightly concave (Fig. 1I–J).

Exoccipital–opisthotics: The fused exoccipital–opisthotics (Fig. 1I–J) make up the majority of the occiput. They are tilted dorsally, flared mediolaterally and are slightly concave on their occipital surfaces. Both exoccipital–opisthoticss are directed posteriorly when seen in dorsal and occipital views. The exoccipital–opisthotics are mediolaterally elongated, as in most other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806; *S. heberti* MNHN.F 1890-13), and contribute to the dorsal and lateral borders of the foramen magnum. The paraoccipital process is rounded and approximately the same size as the rest of the exoccipital, giving it a paddle-shaped appearance in occipital view (Fig. 1I–J). The foramen magnum is large and mediolaterally elongated (oval-shaped), as in other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806; *S. heberti* MNHN.F 1890-13; *Myc. nasutus* CAMSM J.1420). A foramen for cranial nerves XII is located on each side of the foramen magnum; these are large and positioned parallel to the foramen magnum (Fig. 1I–J) (see: Brusatte et al., 2016). The distal part of the right exoccipital–opisthotic is not preserved.

Basioccipital: The basioccipital (Fig. 1C–D, I–J) forms the ventral part of the occiput. The basioccipital is slightly wider than tall and contributes to the foramen magnum. The occipital condyle is large and more circular than the foramen magnum (Fig. 1I–J) and is situated ventral to it. The basioccipital largely forms the occipital condyle. In ventral view, there are two well-developed and slightly dorsoventrally elongated basioccipital tuberosities

(Fig. 1C–D). These tuberosities slope slightly anteroventrally in occipital view (Fig. 1I–J), similar to most teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806; *S. edwardsi* PETMG R178; Machimosaurini), but smaller than those seen in *S. heberti* (MNHN.F 1890-13). There is a large, oval opening for cranial nerve XII (Fig. 1I–J) that is positioned laterally to the foramen magnum. There is also a very small subcircular foramen for cranial nerve IX that is ventrolaterally positioned to cranial nerve XII and parallel to the occipital condyle, seen on the left side of the basioccipital (Fig. 1I–J).

Basisphenoid: The basisphenoid (Fig. 1C–D) is relatively well preserved, although the anterior-most part is not preserved and the overall bone is slightly dorsoventrally crushed. The basisphenoid has two elongated posterolaterally directed processes and comes into posterior contact with the quadrate (Fig. 1C–D).

Pterygoid: The majority of the pterygoid, including the pterygoid wings, is not preserved (Fig. 1C–D). The anterior-most left and right pterygoids appear to be fused into one bone and thin, as in other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806; *S. bollensis* MNHNL TU799; *S. edwardsi* NHMUK PV R 2865; *Myc. nasutus* NHMUK PV R 2617) and contacts the posterior processes of the palatines.

Palatines: The paired palatines (Fig. 1C–D) are dorsoventrally thin, elongate bones and are similar to those seen in other teleosaurids, such as *S. leedsi* (NHMUK PV R 3806), *Myc. nasutus* (NHMUK PV R 2617) and the Chinese teleosauroid (IVPP V 10098). The palatines have a smooth, unaltered surface and are V-shaped (Fig. 1C–D). The posterior-most region of the left palatine is slightly distorted due to breakage and there is a large, sub-horizontal crack filled with matrix across the middle of the palatines (see Fig. 1C–D). The anterior palatines have small anterior processes, which are slightly round and articulate with the posterior process of the maxillae (Fig. 1C–D). These anterior processes reach approximately the 21st maxillary alveolar pair, which differ from machimosaurins [e.g. *Y. boutilieri* (OUMNH J.1403) terminates between the 15th and 19th maxillary alveolar pair and *Mac. buffetauti* (SMNS 91415) terminates between the 11th and 14th maxillary alveolar pair]. The palatines contact one another along the skull

midline until they are posteriorly separated by the anterior process of the pterygoid. The suborbital fenestrae are poorly preserved and only the medial margin (formed by the palatine) of the left suborbital fenestra can be seen (Fig. 1C–D).

Other elements: The ectopterygoids, proötics and laterosphenoids, as well as other small bones of the braincase and palatal region, are not preserved and are, therefore, unavailable for description.

Dentition: Twelve teeth are preserved; four of them are fully mature (see Fig. 1K), and two are missing the apex. Of these teeth, two are from the premaxillae, three from the anterior maxillae, four from the middle maxillae and three from the posterior maxillae. The largest preserved tooth crown (left P3) is apicobasally 0.74 cm long (Fig. 1G–H, K). Throughout the dentition, the teeth (Fig. 1K) are large and robust but with a pointed apex, as opposed to the blunt apices seen in both *L. obtusidens* (e.g. NHMUK PV R 3168), *Y. boutilieri* (OUMNH J.29850) and *Machimosaurus* species (e.g. ONM 1–25; SMNS 91415). The four fully erupted teeth are posteriorly curved. The apicobasal enamel ridges are noticeable and well-developed, parallel to one another and reach the top of the apex (Fig. 1K). There is no mediolateral compression of the teeth (as opposed to *S. heberti* MHNH.F 1890-13) and there are very faint carinae visible all along the tooth crown. No characteristic machimosaurin anastomosing pattern is seen in the apices (Fig. 1K). Overall, the teeth of OUMNH J.29851 are similar in shape, size and ornamentation to those seen in large *S. edwardsi* specimens (e.g. PETMG R178).

Machimosaurini (Jouve et al., 2016)

Machimosaurini indeterminate

(Fig. 2)

v 1995 *Steneosaurus larteti* (Deslongchamps); Vignaud, p. 188.

We have examined two partial mandibles (OUMNH J.1406 and OUMNH J.1417) with in situ teeth that have the characteristic Machimosaurini dental pattern (which consists of blunt, conical teeth with a noticeable anastomosing

pattern on all apices). The first partial mandible, OUMNH J.1406 (Fig. 2A), is from the Great Oolite Group (Bathonian, Middle Jurassic) of North Oxfordshire and is part of the E. A. Walford collection. The anterior-most and posterior areas of the mandible are not preserved. The dentary is an elongate, slender bone that makes up the majority of the lower jaw in crocodylomorphs (Andrews, 1909, 1913; Romer, 1956; Nesbitt, 2011). It is difficult to determine where exactly the mandibular symphysis begins, as the dorsal surface of the dentary is poorly preserved, but it starts approximately at the 16th or 17th alveolus. There are at least 23 dentary alveoli preserved on the left side. The interalveolar spacing is variable throughout the dentary and the alveoli are subcircular in shape (Fig. 2A). In lateral view (Fig. 2A), there are deep reception pits throughout the entirety of the mandible, as well as a single line of large foramina running parallel to the tooth row. OUMNH J.1406 is well ornamented with pits and rugosities in lateral and ventral views (Fig. 2A). There is one partially erupted tooth preserved (Fig. 2A) in the 16th right alveolus. The tooth has a blunt, conical apex with the characteristic anastomosing pattern, and high relief enamel ridges.

The second mandible, OUMNH J.1417 (Fig. 2B), is relatively broad, with only the articulars, posterior surangulars and angulars missing (more so on the right side than the left). As in OUMNH J.1406, the dentary is an elongate bone and makes up the majority of the mandible, with the mandibular symphysis beginning at the 16th alveolus (Fig. 2B). There are 29 alveoli preserved, and the posterior-most alveoli are only slightly smaller than those positioned in the anterior and middle sections of the dentary (Fig. 2B). All alveoli are subcircular in shape with interalveolar spacing varying throughout. The Meckelian groove of OUMNH J.1417 is deep, which differs from other Machimosaurini (e.g. *L. obtusidens* LPP.M.21; *Mac. buffetauti* SMNS 91415). In left lateral view, the surangular is a thin, anteroposteriorly elongated bone. There are deep reception pits present along the lateral margins of the entirety of the mandible, as well as a single line of large foramina running parallel to the tooth row (Fig. 2B). There are numerous large subcircular fenestrae in dorsal, lateral and ventral views in the anterior-most part of the dentary (Fig. 2B), arranged in a semicircular pattern around the D1 to D4 alveoli. There are five partially erupted teeth (third left alveolus

and second, 16th, 18th and 22nd right alveoli) (Fig. 2B). All teeth are robust with a blunt apex and all preserve the characteristic anastomosing pattern.

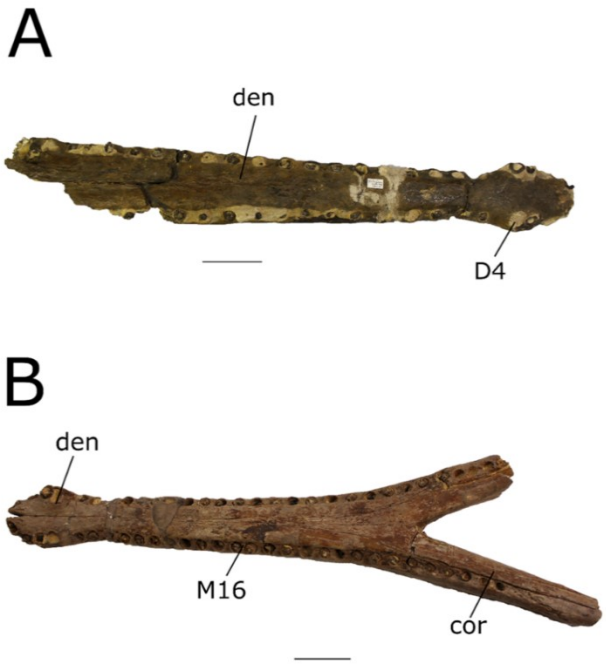


Figure 2. Photographs of Machimosaurini indeterminate, (A) OUMNH J.1406, and (B) OUMNH J.1417. Refer to the main text for the abbreviations list. Scale bars: 5 cm.

Yvridiosuchus M. M. Johnson, M. T. Young & S. L. Brusatte, **comb. nov.**

(Figs. 3–5)

Type species: *Teleosaurus boutilieri* Eudes-Deslongchamps, 1868c (following recommendation 67B of the ICZN Code). Now referred to as *Yvridiosuchus boutilieri* (Eudes-Deslongchamps, 1868c), **comb. nov.** urn:lsid:zoobank.org:act:86F9050C-5C7C-46A1-8962-0BCE26A7ACE4

Diagnosis: Same as the only known species (monotypic genus).

Etymology: ‘Hybrid crocodile’. *Yvrídio* (υβρίδιο) is Ancient Greek for ‘hybrid’ (referring to the unique combination of machimosaurin synapomorphies and non-machimosaurin teleosauroid symplesiomorphies present in this genus), and *suchus* is the Latinized form of the Greek *soukhos* (σοῦχος), meaning crocodile.

Yvridiosuchus boutilieri (J. A. Eudes-Deslongchamps, 1868c), **comb. nov.**

v 1821 Partial crocodile skull; Conybeare in: De la Bêche & Conybeare, p. 591.

v 1822 Partial crocodile skull; Conybeare; Conybeare & Phillips, p. 208.

v* 1868a *Teleosaurus boutilieri* sp. nov.; J. A. Eudes- Deslongchamps, pp. 112–118, pl. 5 Figs. 1–6.

v 1868b *Teleosaurus boutilieri* (Deslongchamps); J. A. Eudes-Deslonchamps, pp. 121–129, pl. 5, Figs. 8–10.

v 1867–69 *Steneosaurus boutilieri* (Deslongchamps); E. Eudes-Deslongchamps, p. 228, pl. 16, Figs. 1–2.

v 1870a *Steneosaurus boutilieri* (Deslongchamps); E. Eudes-Deslongchamps, p. 329.

vp 1871 *Teleosaurus brevidens* sp. nov.; Phillips, pp. 185–187, fig. 44.1.

v 1936 *Steneosaurus boutilieri* (Deslongchamps); Kuhn, p. 38.

v 1951 *Steneosaurus meretrix* sp. nov. (Deslongchamps); Phizackerley, p. 1177, Figs. 4–6.

v 1973 *Steneosaurus boutilieri* (Deslongchamps); Steel, p. 31.

(?) 1981 *Steneosaurus* sp.; Rieppel, p. 739, fig. 2.

v 1995 *Steneosaurus boutilieri* (Deslongchamps); Vignaud, pp. 186–187, pl. 2, Figs. a–b.

v 1996 *Steneosaurus boutilieri* (Deslongchamps); Godefroit et al., p. 98.

1998 *Steneosaurus boutilieri* (Deslongchamps); Mazin et al.

v 1998 *Steneosaurus boutilieri* (Deslongchamps); Vignaud, p. 22.

Holotype: A skull fragment figured by J. A. Eudes-Deslongchamps (1867–69), presumed to be lost or destroyed (Vignaud, 1995).

Holotype locality and horizon: '*Sommet de la Grande Oolithe*', Calvados, France.

Neotype: OUMNH J.1401, comprising an incomplete skull, with areas posterior to the orbits missing.

Designation of neotype: Herein we formally designate OUMNH J.1401 as the neotype of *Y. boutilieri*. In order to be in full accordance of Article 75 of the ICZN Code, in particular Article 75.3, we make the following statements:

1. This designation is made with the express purpose of clarifying the taxonomic status of *Y. boutilieri*.
2. Our statement of the characters that we regard as differentiating *Y. boutilieri* from other taxa is given by the species diagnosis below.
3. The neotype can be recognized through both the description below and Fig. 3.
4. The holotype is presumed destroyed in 1944 during the bombing of Caen.
5. The holotype had a partial skull; the description and figure given by E. Eudes-Deslongchamps (1867–69) showed it to be large, rugose and robust with broad, rounded palatines and robust teeth. As such, the neotype is consistent with what is known of the former name-bearing type.
6. Unfortunately, the neotype is not from the same locality or country as the holotype. However, E. Eudes-Deslongchamps compared the holotype with our proposed neotype, and considered that they were of the same species and included both in his future description of the species. In addition, both the holotype and our proposed neotype come from the equivalent to the GOG in England.
7. The neotype is the property of a recognized scientific institution, OUMNH, which maintains a research collection with proper facilities for preserving name-bearing types and is accessible for study.

Neotype locality and horizon: Cornbrash Formation, Great Oolite Group, Enslow Bridge, UK. Bathonian, Middle Jurassic.

Referred specimens: OUMNH J.29580, a complete skull and mandible (type specimen of T. brevidens and 'S'. meretrix). OUMNH J.1403, a nearly complete skull. OUMNH J.1404, a partial mandible.

Etymology: 'Boutilier's hybrid crocodile'. Yvrídio (υβρίδιο)' is Ancient Greek for 'hybrid', and 'σοῦχος (*soûkhos*)' is Ancient Greek for crocodile. Named after Mr Boutilier, who gave the type specimen to Eugène Eudes-Deslongchamps.

Emended diagnosis: Teleosauroid crocodylomorph with the following unique combination of characters among teleosauroids (autapomorphic characters indicated by an asterisk *): mesorostrine skull (rostrum less than 68% of total skull length) (shared with '*S. brevior*', the Chinese teleosauroid IVPP V 10098, *D. larteti*, *S. edwardsi* and Machimosaurini); skull ornamented with conspicuous pits and grooves; heavily ornamented prefrontal and lacrimal (shared with '*S. brevior*' and *Myc. nasutus*); large and numerous neurovascular foramina on the premaxillae, maxillae and dentaries' (shared with '*S. brevior*' and Machimosaurini); external nares oriented dorsally (shared with *S. gracilirostris*, *S. bollensis*, *S. leedsi*, *S. heberti*, *D. larteti*, *S. edwardsi* and Machimosaurini); presence of antorbital fenestrae; frontal width subequal with orbital width (shared with the Chinese teleosauroid IVPP V 10098, *Myc. nasutus*, *S. heberti*, *D. larteti*, *Mac. hugii* and *Mac*. *rex*); squamosal projects further posteriorly than occipital condyle (shared with the Chinese teleosauroid IVPP V 10098, *S. edwardsi* and Machimosaurini); orbit subcircular in shape (similar to other members of Machimosaurini); anterior process shape of palatine U-shaped*; Meckelian canal (=groove) is not deeply excavated on the dorsal surface of the splenials (shared with *S. heberti*, *S. edwardsi*, *L. obtusidens* and *Machimosaurus*); sharp dorsoposterior curvature of the posterior mandibular rami (shared with *S. heberti* and Machimosaurini); width of mid-retroarticular process is substantially narrower than the glenoid fossa*; teeth with no mediolateral compression (shared with *B. megarhinus*, *D. larteti*, *S. edwardsi* and

Machimosaurini); maxillary teeth not procumbent (shared with *S. heberti*, *S. edwardsi* and Machimosaurini).

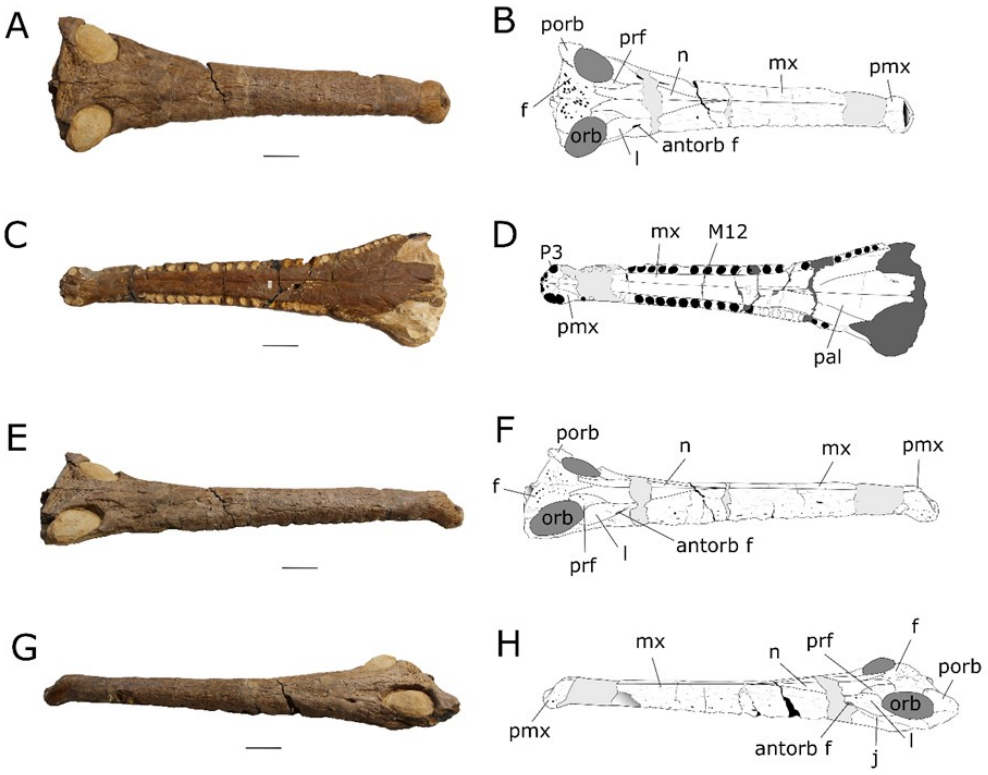


Figure 3. Photograph (A, C) and line drawing (B, D) of *Yvridiosuchus boutilieri* (Eudes-Deslongchamps, 1868) **comb. nov.**, OUMNH J.1401, neotype. Skull in dorsal (A-B), palatal (C-D), and right (E-F) and left (GH) lateral views. Lighter shading indicates plaster, and darker shading represents matrix. Refer to the main text for the abbreviations list. Scale bars: 5 cm.

Description

The neotype of *Y. boutilieri* (OUMNH J.1401) (Fig. 3) is a partial rostrum, preserved from the anterior-most part of the snout until the anterior margin of the supratemporal fenestrae. OUMNH J.1401 is broken into two sections (Fig. 3): the first piece is complete from the anterior margin to the right M15 and left M18 alveoli (a posteriorly directed horizontal break) and the second piece includes the right M15 alveolus back to the supratemporal fenestra anterior margin. One area of the rostrum (including the right fourth premaxillary alveolus and the first four maxillary alveoli on both sides) is reconstructed with plaster (see Fig. 3). Two referred specimens, OUMNH J.29850 (Fig. 4) and OUMNH J.1403 (Fig. 5A–F), represent additional skull

material, including the palate (OUMNH J.1403) and the majority of the mandible (OUMNH J.29850). The premaxillary bones are not preserved in OUMNH J.1403 and the skull of OUMNH J.29850 is cemented to the mandible so that the palatal surface is not visible. In addition, OUMNH J.1404 (Fig. 5G–H), a partial mandible, has been referred to as '*S*.' *boutilieri* so we describe it here as well (however, it is unknown who referred this specimen to the species *boutilieri*, or when they did so).

Cranium: The crania of all aforementioned *Y. boutilieri* specimens (OUMNH J.1401, OUMNH, J. 29850, OUMNH J.1403) are massive and rugose (Figs. 3, 4, 5A–F) and are heavily ornamented with multiple, deep, circular foramina, particularly around the premaxillae and anterior maxillae (see Description). The orbits are subcircular (Figs. 3A–B, E–H, 4A–B, E–H, 5A–B) and are slightly more anteroposteriorly elongated than other members of Machimosaurini (e.g. *L. obtusidens* LPP.M.21, *Mac. buffetauti* SMNS 91415, *Mac. mosae* IRSNB cast). In both OUMNH J.29850 and OUMNH J.1403, the supratemporal fenestrae are parallelogram-shaped (Figs. 4A–B, 5A–B). The entire cranium of OUMNH J.29850 measures approximately 78 cm from the anterior-most premaxillae to the posterior-most quadrates and the quadrate-to-quadrate length is approximately 21 cm.

Premaxillae: The premaxillae (Figs.. 3, 4A–H) are robust and surround the external narial opening. The external nares face dorsally, are laterally expanded and their posterior margins do not reach beyond the third premaxillary alveolar pair. The anterior two-thirds of the premaxilla is slightly laterally expanded and anteroposteriorly shortened, and the anterior margin is ventrally deflected. In dorsal view, the premaxilla–maxilla suture is subcircular in shape and slightly interdigitating (Figs. 3A–B, 4A–B). The incisive foramen (=naso-oral fenestra) is very small and is situated in the middle of the suture of the premaxillae. In OUMNH J.1401, four premaxillary alveoli are present (Fig. 3C–D). While the mandible of OUMNH J.29850 (4A–H) obscures the majority of the premaxillae of the ventral view, the lateral margins of four alveoli are also visible. The first two premaxillary alveoli are nearly confluent, with a thin interalveolar lamina separating them. The third and fourth premaxillary alveoli are well-separated (Fig. 3C–D) (see: Foffa et

al., 2019). Both premaxillae are strongly ornamented with conspicuous pits and grooves (Figs. 3, 4A–H), and in dorsal and lateral views there is a clustering of large circular foramina along the anterior and lateral margins of the external nares (Figs. 3E–H, 4E–H).

Maxillae: The maxillae (Figs.. 3A, 4A–H, 5A–D) form a substantial part of the rostrum. The elongated maxillae are transversely narrow and anteriorly separated by the premaxillae (Figs. 3, 4A–H, 5A–D). In dorsal view, the maxillary lateral margins are subparallel, and the premaxillae and nasals are separated by the maxillae. In OUMNH J.1401, there are at least 26 maxillary alveolar pairs; in OUMNH J.29850, there are at least 25; and in OUMNH J.1403, there are at least 23 (with the anterior-most maxillae not being preserved). The reception pits are deep throughout the entirety of the maxilla, which is ornamented with well-developed pits and grooves. In addition, there are numerous, deep, well-spaced foramina (arranged in two lines parallel to the maxillary ventral margin) that are best visible in lateral views (Figs. 3E–H, 4E–H).

Jugals: The jugals (Figs. 3E–H, 4E–H, 5A–B) are triradiate, forming the lateral border of the orbit, as in other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806; the Chinese teleosauroid IVPP V 10098; *S. heberti* MNHN.F 1890-13). In OUMNH J.1401, the anterior jugal is somewhat difficult to see but is better preserved on the left side and appears to extend anteriorly past the orbits (Fig. 3G–H). In OUMNH J.29850, the jugals also extend anteriorly past the orbits (Fig. 4E–H). The jugal participates in the ventral margin of the orbit, and the postorbital–jugal contact (best seen in right lateral view) appears to be anteroposteriorly straight. The quadratojugal–jugal contact is not preserved in any specimen.

Nasals: The nasals (Figs. 3A–B, E–H, 4A–B, E–H, 5A–B) are large triangular bones exposed on the dorsal surface of the posterior rostrum and orbital area. The lateral margins of the nasals are strongly confluent and the anterior area is mediolaterally narrow, as in other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806, *D. larteti* OUMNH J.29851, *S. edwardsi* NHMUK PV R 2865). In OUMNH J.29850, it is difficult to describe the anterior-most nasals, as there is some slight discoloration in that particular area of the skull (Fig.

4A–B). The nasal anterior processes have a near-parallel sutural contact with the maxillae. In OUMNH J.1401, OUMNH J.1403 and OUMNH J.29850, there is no dorsoventral 'doming' of the nasals and there is a faint internarial suture, suggesting that the nasals are unfused (both features differ from *L. obtusidens* specimens NHMUK PV R 3168, PETMG R39, LPP.M.21, NOTNH FS336, in which there is a dorsoventral 'dome' in the posterior nasals and no internarial suture is present).

Prefrontals: The prefrontals (Figs. 3A–B, 4A–B, G–H, 5A–B) are subcircular and longer than wide in dorsal view. The prefrontal forms the anteromedial border of the orbits, and contacts the nasal and frontal medially and the lacrimal laterally (Figs. 3A–B, 4A–B, G–H, 5A–B). The prefrontal–frontal contact is irregular and the prefrontal–lacrimal contact is relatively straight. In OUMNH J.1401, the prefrontal is ornamented with small and grooves, similar to those seen in *S. bollensis* (e.g. SMNS 51563, SMNS 51555, SMNS 59736).

Lacrimals: The lacrimals (Figs. 3A–B, E–H, 4A–B, E–H, 5A–B) are substantially sized triangular bones that constitute the majority of the anterolateral margins of the orbits and can be observed in both dorsal and lateral views (Figs. 3A–B, E–H, 4A–B, E–H, 5A–B). The lacrimals are well ornamented with small pits and grooves (similar to *Myc. nasutus* (NHMUK PV R 2617) and '*S. brevior*' (NHMUK PV OR 14781), but not as heavily ornamented as those two taxa). The paired antorbital fenestrae are small and anteroposteriorly elongated (Figs. 3A–B, E–H, 4A–B, E–H, 5A–B), with the right being better preserved than the left in OUMNH J.29850.

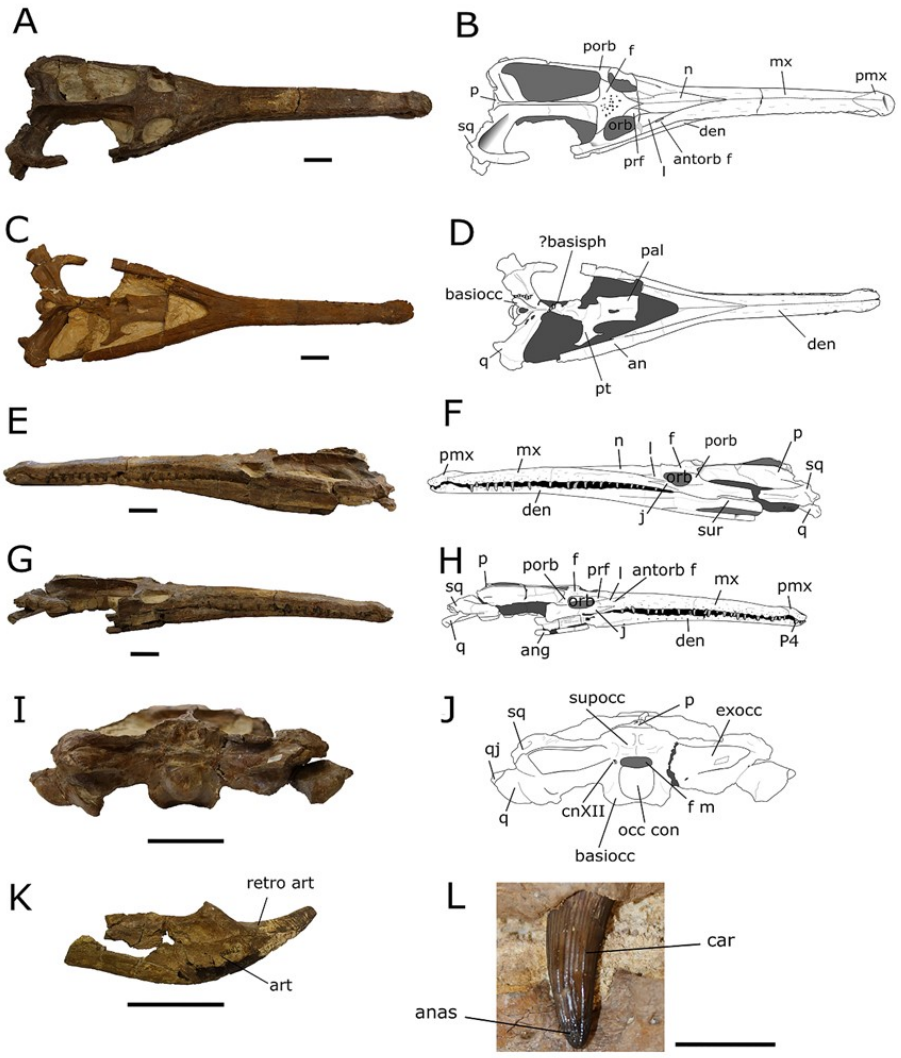


Figure 4. Photographs (A, C, E, G, I, K, L) and line drawings (B, D, F, H, J) of *Yvridiosuchus boutilieri* (Eudes-Deslongchamps, 1868) **comb. nov.**, OUMNH J.29850, referred specimen. Skull in dorsal (A-B), palatal (C-D) left (E-F) and right (G-H) lateral, and occipital (I-J) views. Left retroarticular process (K) in left lateral view, and maxillary tooth (L) in labial view. Note the anastomosing pattern at the apex of the tooth (L). Refer to the main text for the abbreviations list. Scale bar: 5 cm (A-K) and 1 cm (L).

Frontal: In OUMNH J.1401, OUMNH J.1403 and OUMNH J.29850, the frontal (Figs. 3A–B, E–H, 4A– B, E–H, 5A–B) is a dorsoventrally deep bone and there is no evidence of a midline suture. The frontal contributes to the posteromedial border of the orbits, forms a relatively straight vertical contact with the postorbital in dorsal and lateral views and forms the anterior medial borders of the supratemporal fenestrae (Figs. 3A–B, E–H, 4A–B, E–H, 5A–B). The anterior process is longer than other machimosaurins (e.g. *L. obtusidens* NHMUK PV R 3168), with the length being similar to *S. stephani* (NHMUK PV OR 49126). The frontal is ornamented with pits and grooves

that are restricted to the centre of the bone. In OUMNH J.1403, the posterior frontal contacts the parietal (Fig. 5A–B).

Postorbitals: The postorbitals (Figs. 3A–B, E–H, 4A– B, E–H, 5A–B), best preserved in OUMNH J.29850 and OUMNH J.1403, reach the orbit posteroventral margin (with the postorbital overlapping the jugal), and extensively form parts of the orbit ventral margins (similar to *Pl. multiscrobiculatus* SMNS 9930). The postorbital also forms the lateral and posteroventral margins of the supratemporal fenestra (Figs. 4A–B, E–H, 5A–B). The anterodorsal suture interdigitates tightly with the frontal and forms the posterior margin of the orbit. In OUMNH J.29850 and OUMNH J.1403, the postorbital is noticeably larger and more elongate than the squamosal, and the postorbital–squamosal contact is straight (best seen in lateral view; Fig. 4E–H). The anterodorsal area of the postorbital is slightly anteroposteriorly constricted (Figs. 4A–B, E–H, 5A–B), whereas the rest of it is anteroposteriorly broad. The postorbital bar (formed by the frontal–postorbital contact) is similar to other teleosauroids (e.g. *S. bollensis* SMNS 51753; *S. edwardsi* PETMG R178; *D. larteti* OUMNH J.29851; *L. obtusidens* LPP.M.21), being slightly anteroposteriorly thickened, having small sparse pits for ornamentation and forming the posterolateral margin of the orbit.

Parietal: The parietal (Figs. 4A–B, E–H, 5A–B) is a relatively large and mediolaterally thickened single bone with no trace of a midline suture, with dorsal ornamentation that consists of two or three elliptical pits. The parietal contributes to the posterior and medial borders of the supratemporal fenestrae and does not overhang the occiput in dorsal view. The parietal bar is relatively thin, anteroposteriorly elongated and the posterior region is anteriorly concave.

Squamosals: The squamosals (Figs. 4A–B, E–H, 5A–B) are elongate L-shaped bones. The anterior process is anteroposteriorly elongated (in dorsal view), and forms the posterolateral border of the supratemporal fenestrae. The posterolateral surface of the squamosal is concave in lateral view and convex in dorsal view (Figs. 4A–B, E–H, 5A–B). The squamosal bar is robust and anteriorly contacts the postorbital bar (together forming the supratemporal arch).

Quadrates: In OUMNH J.29850, only the left quadrate (Fig. 4E–F) is well preserved and strongly sutured to the squamosal and quadratojugal. The anterodorsal region of the quadrate contacts the squamosal and quadratojugal, while the posteroventral margin articulates with the articular (=jaw joint) and medially contacts the exoccipital–opisthotic. Both hemicondyles are similar in size (as seen in most other teleosauroids such as *S. bollensis* SMNS 59736; *L. obtusidens* NHMUK PV R 3168, but differing in *Machimosaurus*, e.g. *Mac. buffetauti* SMNS 91415; *Mac. mosae* IRSNB cast), oval-shaped, mediolaterally elongate and have rounded posterior edges. On the occiput, the hemicondyles extend slightly more posteriorly than the exoccipital–opisthotics (Figs. 4I–J, 5E–F).

Quadratojugals: Only the left posterior-most quadratojugal is preserved in OUMNH J.29850 (Fig. 4A–B), with the posterior region being mediolaterally expanded to accommodate the quadrate.

Ectopterygoids: In OUMNH J.1403, the ectopterygoids are short and broad (Fig. 5C–D) and similar to other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3320; *Myc. nasutus* NHMUK PV R 2617). The ectopterygoid contacts the maxilla anteriorly and the pterygoid posteriorly and the ventral surface is slightly concave and curves ventromedially (Fig. 5C–D).

Supraoccipital: In OUMNH J.29850 and OUMNH J.1403, the supraoccipital (Figs. 4I–J, 5E–F) is positioned ventral to the parietal and is only visible in occipital view. It forms the dorsomedial part of the occiput and contributes to the dorsal margin of the foramen magnum (Figs. 4I–J, 5E–F). The ventral edge is triangular and there is no evidence of a pronounced nuchal crest, differing from *S. gracilirostris* (MNHNL TU515) and *L. obtusidens* (NHMUK PV R 3168). The supraoccipital is dorsoventrally tall, slightly mediolaterally expanded (more so dorsally than ventrally), not broadly exposed in dorsal view and slightly concave in occipital view.

Exoccipital–opisthotics: In OUMNH J.29850 and OUMNH J.1403, the exoccipital–opisthotics (Figs. 4I–J, 5E–F) make up the majority of the occiput. In OUMNH J.1403, the right exoccipital–opisthotic is not preserved and the anterior part of the left is missing. They are tilted dorsally, flared

mediolaterally and are slightly concave on their occipital surfaces. Both exoccipital– opisthotics are strongly directed posteriorly, dorsoventrally tall and mediolaterally short compared to other non-machimosaurin teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806; *S. edwardsi* NHMUK PV R 3701; *S. heberti* MNHN.F 1890-13) and contribute to the dorsal and lateral borders of the foramen magnum. The paraoccipital process is rounded and the same size as the rest of the exoccipital–opisthotic, giving it a paddle-shaped appearance in occipital view (Figs. 4I–J, 5E–F). The foramina for cranial nerves XII are large, situated lateral to, and on the same plane as, the foramen magnum and are housed in an oval-shaped fossa (Figs. 4I–J, 5E–F) similar to other teleosauroids (e.g. *S. heberti* MNHN.F 1890-13; *Steneosaurus baroni* Newton, 1893, NHMUK PV R 1999; *L. obtusidens* LPP.M.21).

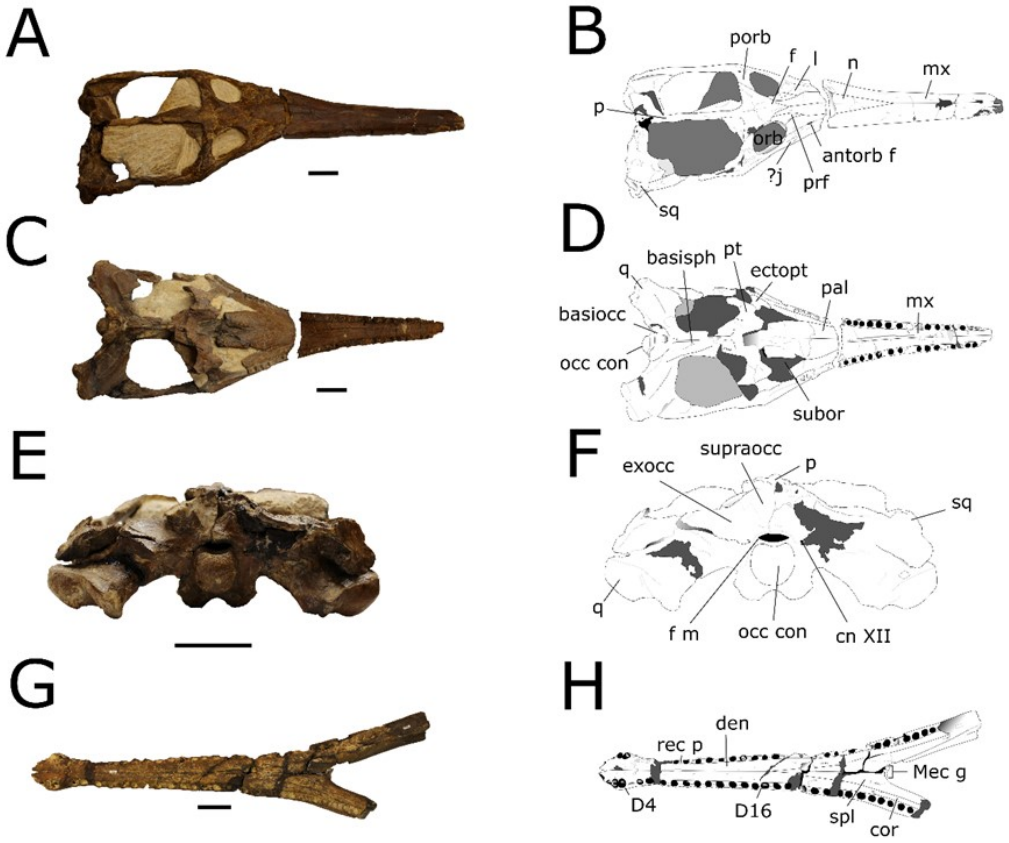


Figure 5. Photographs (A, C, E, G) and line drawings (B, D, F, H) of *Yvridiosuchus boutilieri* (Eudes-Deslongchamps, 1868) **comb. nov.**, OUMNH J.1403 (A-F) and OUMNH J.1404 (G-H), referred specimens. Skull in dorsal (A-B), palatal (C-D) and occipital (E-F) views, and partial mandible (G-H) in dorsal view. Darker shading represents matrix. Refer to the main text for the abbreviations list. Scale bars: 5 cm.

Basioccipital: The basioccipital (Figs. 4I–J, 5E–F) forms the ventral part of the occiput. The basioccipital contributes to the ventral margin of the foramen magnum and is slightly wider than tall. The occipital condyle is larger and more circular than the foramen magnum (Figs. 4I–J, 5E–F). The sutures between the occipital condyle and the basioccipital are not visible. In OUMNH J.29850, there is a small circular foramen ventrolateral to cranial nerve XII and on the same plane as the occipital condyle on the left side of the basioccipital; this could possibly be the opening for cranial nerve IX (see: Brusatte et al., 2016). Also, in OUMNH J.29850, another large, circular foramen is situated lateral to the foramen magnum and ventral to the proximal paroccipital process. This opening is interpreted as either the vagus nerve (cranial nerve X) or a combination of the vagus, accessory (cranial nerve XI) and possibly glossopharyngeal (cranial nerve IX; see: Brusatte et al., 2016). The basioccipital tuberosities are slightly enlarged relative to most other teleosauroids, as in other members of Machimosaurini (e.g. *L. obtusidens* LPP.M.21; *Mac. mosae* [Hua, 1999; Young et al., 2014a]; *Mac. hugii* MG-8730–2), but smaller than those seen in *S. heberti* (MNHN.F 1890-13).

Basisphenoid: In both OUMNH J.1403 and OUMNH J.29850, the basisphenoid (Figs. 4C–D, 5C–D) has two elongated posterolaterally directed processes and comes into posterior contact with the quadrate. It is anteroposteriorly short and contacts the pterygoid anteriorly. In OUMNH J.1403, the basisphenoid is exposed along the palatal surface anterior to the quadrates and bifurcates the posterior part of the single pterygoid (Fig. 5C–D).

Pterygoid: In ventral view, the single fused pterygoid is well preserved in OUMNH J.1403 (Fig. 5C–D), as well as on the right side in OUMNH J.29850 (Fig. 4C–D). The pterygoid is anteroposteriorly elongated and mediolaterally expanded. It is also slightly dorsoventrally thick in comparison with other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806; the Chinese teleosauroid IVPP V 10098). The anterior pterygoid process articulates with the palatines. The pterygoid is concave and posterodorsally curved, most notably in the posterior area (Figs. 4C–D, 5C–D) and contributes to the medial and

posterior borders of the suborbital fenestrae, which are tear-shaped (rounded posteriorly, thin and 'V'-shaped anteriorly and mediolaterally wide). The suborbital fenestrae are partially preserved in OUMNH J.1401 (Fig. 3C–D) and are slightly broken around the lateral margins; however, they are relatively well preserved in OUMNH J.1403 (especially the left suborbital fenestra; Fig. 5C–D).

Palatines: The paired palatines (Figs. 3C–D, 5C–D) are dorsoventrally thin, elongate bones and are similar to those seen in other teleosauroids (such as *D. larteti* OUMNH J.29581, *S. leedsi* NHMUK PV R 3320, the Chinese teleosauroid IVPP V 10098). In both OUMNH J.1401 and OUMNH J.1403, the palatines have a smooth, unaltered surface and are relatively U-shaped (Figs. 3C–D, 5C–D). The anterior palatines are rounded, with relatively small anterior processes (best seen in OUMNH J.1403) and articulate with the posterior processes of the maxillae (Fig. 5C–D). The palatines contact one another along the skull midline until they are posteriorly separated by the anterior process of the pterygoid. In OUMNH J.29850, the posterior palatines strongly contact the pterygoid (Fig. 4C–D), slightly overlapping it. In OUMNH J.1401, the palatines reach the 19th or 20th maxillary alveolar pairs, which is similarly seen in other teleosauroid taxa (e.g. *D. larteti* OUMNH J.29851).

Other elements: In all specimens, the proötics are not visible and the laterosphenoids are poorly preserved. We were, therefore, unable to describe these bones properly.

Mandible: The nearly complete mandible of OUMNH J.29850 (Fig. 4A–H) is cemented to the cranium, so the dorsal surface is not visible, as mentioned above. It measures approximately 74 cm in length; however, the posterior-most part of the mandible is not preserved. In OUMNH J.1404, the dorsal surface of the partially complete mandible is exposed (Fig. 5G–H), with the posterior portion not preserved.

Dentary: In both OUMNH J.29850 and OUMNH J.1404, the dentary (Figs. 4A–H, 5G–H) is an elongate, slim bone making up most of the lateral and ventral surfaces of the mandible (e.g. Andrews, 1909, 1913; Romer, 1956; Nesbitt, 2011). In OUMNH J.1404, the Meckelian groove is shallow and not

deeply excavated on the dorsal surface of the splenials (Fig. 5G–H), which is also seen in *S. heberti* (MNHN.F 1890-13), *S. edwardsi* (NHMUK PV R 3701), *L. obtusidens* (LPP.M.21) and *Machimosaurus* (e.g. SMNS 91415). In dorsal view, the coronoid groove (best seen on the left side) is mediolaterally thick and penetrates deeply into the dentary (Fig. 5G–H). In OUMNH J.29850, the exact number of alveoli is difficult to discern but there are at least 29 alveoli per side (although the anterior-most dentary is missing); in OUMNH J.1404, there are at least 29 alveoli on the left side and 31–32 on the right (Fig. 5G–H). The alveoli are large and circular, with the interalveolar distance being slightly larger than the alveolar labiolingual width (Fig. 5G–H) and the interalveolar spacing ranges from large to small throughout the entirety of the mandible. In OUMNH J.1404, the posterior-most alveoli are approximately the same size as the anterior- and middle-situated alveoli (Fig. 5G–H), which differs from other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806, *S. edwardsi* NHMUK PV R 3701, *Myc. nasutus* NHMUK PV R 2617, *Aeolodon priscus* von Sömmering, 1814 NHMUK PV R 1086, *L. obtusidens* LPP.M.21) and is similar to *S. heberti* (MNHN.F 1890-13).

Surangular and angular: In both OUMNH J.29850 and OUMNH J.1404, the surangular (Figs. 4C–H, 5G–H) is a thin and anteroposteriorly elongate bone in lateral view, and in conjunction with the angular and articular, forms a distinctive ‘V’ shape. In OUMNH J.1404, the anterior surangular terminates near the final alveolus of the dentary. In OUMNH J.29850, the angular (Fig. 4C–H) occupies a larger area than the surangular and is ventral to it. The angular is dorsoventrally deeper and more robust than the surangular and has a poor dorsal curvature in lateral view, similar to other teleosauroids (e.g. *S. leedsi* NHMUK PV R 3806, *S. edwardsi* NHMUK PV R 3701). In OUMNH J.29850, the left mandibular fenestra is anteroposteriorly elongated and dorsoventrally thin (Fig. 4E–F).

Articular: In OUMNH J.29850, the left articular is not preserved, but the right articular is a separated piece from the mandible (Fig. 4K). In lateral view, the posterior mandibular rami is sharply curved dorsoposteriorly, similar to *S. heberti* (MNHN.F 1890-13) and Machimosaurini. The retroarticular process is anteroposteriorly elongate, mediolaterally thin and triangular-shaped in dorsal

view (Fig. 4K). The anteroposterior keel is small and thin but visible, and the posterior end of the retroarticular process is slightly rounded. The middle area of the retroarticular process is substantially narrower than the glenoid fossa (39%), as opposed to other teleosauroids (e.g. 55% in *S. edwardsi* PETMG R178, 53% in *S. leedsi* NHMUK PV R 3320, 65% in *S. heberti* MNHN.F 1890-13).

Dentition: Throughout the dentition, the teeth (Fig. 4L) of *Y. boutilieri* are large and robust with a blunt apex, and are more similar to *Lemmysuchus* than *Machimosaurus*, being slightly less conical and weakly curved in the anterior dentary. In OUMNH J.29850, the largest tooth (M14) measure approximately 1.5 cm in apicobasal length. The enamel ridges are small yet well-developed, parallel to one another and reach the top of the apex. The enamel is thinner towards the base of the crown and becomes progressively thicker towards the apex (Fig. 4L), similar to that seen in *Lemmysuchus* and *Machimosaurus* (Young & Steel, 2014; Johnson et al., 2017). There are numerous protruding apicobasal enamel ridges on the teeth, giving them a ‘wrinkled’ texture; these apicobasal ridges are close to one another and run parallel from the base of the crown to approximately three quarters of the entire tooth. At the apex, the ridges are considerably shorter and are organized in the typical anastomosed pattern that has been described for other members of Machimosaurini (*L. obtusidens* NHMUK PV R 3168, *Mac. buffetauti* SMNS 91415, *Mac. hugii* MG-8730–1, *Mac. rex* ONM 1–25; Young et al., 2014a, 2015a; Jouve et al., 2016; Johnson et al., 2017). The teeth have true denticles and false denticles (Young et al., 2015a), although the latter cannot be seen clearly with the naked eye.

PHYLOGENETIC ANALYSIS

1.1 Methods

We conducted a phylogenetic analysis to test the evolutionary relationships of *D. larteti* and *Y. boutilieri* in Thalattosuchia, using a modified version of the dataset provided by Foffa et al. (2019), which is based on Ősi et al. (2018).

This dataset is continuously being updated, as it forms the foundation of the ongoing Crocodylomorph SuperMatrix Project. The dataset was first presented in Ristevski et al. (2018), but it has been extensively updated subsequently (for full details, see: Ősi et al., 2018; Foffa et al., 2019). All data are summarized in Appendix S1 (Supplementary Files 1-3).

The current dataset consists of 143 crocodylomorph OTUs (70 of which are thalattosuchians, including 18 teleosauroids, 7 basal metriorhynchoids and 42 metriorhynchids) scored for 464 characters. Of these 464 characters, 25 characters representing morphoclines were treated as ordered (see Appendix S1). *Postosuchus kirkpatricki* Chatterjee, 1985 was used as the outgroup taxon. The differences between our analyses and those presented by Foffa et al. (2019) are: (1) the inclusion of a new taxon, *Y. boutilieri*, (2) the rescoring of *D. larteti*, (3) the rescoring of '*S. brevior*' and (4) a reorganization of the character list, with the addition of eight new characters (ch. 17, 18, 176, 355, 362, 367, 374, 464). The character scorings for both *Y. boutilieri* and *D. larteti* were based on first-hand examination of the relevant material by MMJ. *Deslongchampsina larteti* was scored for 225 out of 464 characters (48.4%) and *Y. boutilieri* was scored for 292 out of 464 characters (62.9%).

The cladistic maximum parsimony analysis of the dataset was conducted using TNT 1.5 Willi Hennig Society Edition (Goloboff et al., 2008; Goloboff & Catalano, 2016), following the methodology used in Young et al. (2016). Memory settings were increased with General RAM set to 900 Mb and the maximum number of trees to be held set to 99 999. Cladogram space was searched by means of the 'New Technology search' option in TNT (Sectorial Search, Ratchet, Drift and Tree fusing) with 1000 random-addition replicates (RAS). In addition, we increased the default setting for the iterations of each method (except for Tree fusing, which was kept at three rounds). In the Sectorial Search we ran 1000 Drift cycles (for selections of above 75) and 1000 starts and fuse trees 1000 times (for selections below 75), as well as 1000 rounds of Consensus Sectorial Searches (CSSs) and Exclusive Sectorial Searches (XSSs). For Ratchet, the program used 1000 ratchet iterations set to stop the perturbation when 1000 substitutions were

made or 99% of the swapping was reached. Lastly, in Drift, the analysis included 1000 Drift cycles set to stop the perturbation when 1000 substitutions were made or 99% of the swapping was reached. The collapsing rule used was 50%. In addition to the strict unweighted consensus, we (1) analysed a majority rules unweighted consensus (cut-off 50%) and (2) ran the analysis once more using implied weighing (k = 12).

***1.2** Results*

The phylogenetic analysis produced 201 most parsimonious trees (MPTs) with 1526 steps (ensemble consistency index (CI) = 0.415, ensemble retention index (RI) = 0.845, ensemble rescaled consistency index (RCI) = 0.351, ensemble homoplasy index (HI) = 0.585; Fig. 6A). The overall strict consensus topology recovered from this analysis is extremely similar to that presented by Ristevski et al. (2018), Ősi et al. (2018) and Foffa et al. (2019).

In the strict consensus tree (Fig. 6A), both *D. larteti* and *Y. boutilieri* were recovered in the teleosauroid subclade that includes typical '*Steneosaurus*' taxa (e.g. *S. leedsi*) along with the durophagous tribe Machimosaurini (consisting of *Lemmysuchus* and *Machimosaurus*). *Yvridiosuchus boutilieri* is recovered in a polytomy with *L. obtusidens* and *Machimosaurus* taxa, but is clearly situated in tribe Machimosaurini. *Deslongchampsina larteti* is recovered in an unresolved position with *S. heberti* and the clade containing *S. edwardsi* and Machimosaurini (including *Y. boutilieri*). It is worth noting that *S. gracilirostris*, currently considered the basal-most teleosauroid (see: Ősi et al. 2018; Foffa et al., 2019), forms an unresolved polytomy with *S. bollensis*, '*S. brevior*' and the Chinese teleosauroid (IVPP V 10098).

The majority rule consensus tree shows increased resolution (Fig. 6B). It places *D. larteti* as the sister taxon to the group containing *S. heberti*, *S. edwardsi* and Machimosaurini. The machimosaurin genera *Yvridiosuchus*, *Lemmysuchus* and *Machimosaurus* continue to be in a trichotomy. *Steneosaurus gracilirostris* is positioned as the basal-most teleosauroid, as in Foffa et al. (2019).

Lastly, when the analysis was run once again using implied weighting (Fig. 6C): (1) *D. larteti* is recovered as the sister-group to *S. heberti* + *S. edwardsi* + Machimosaurini; (2) *Y. boutilieri* resolves in Machimosaurini (but again with the genera being in a trichotomy); and (3) *S. gracilirostris* is the basal-most teleosauroid. The Chinese teleosauroid (IVPP V 10098) is placed as sister to the grouping including '*S. brevior*', *Myc. nasutus*, *Ae. priscus* and *B. megarhinus*.

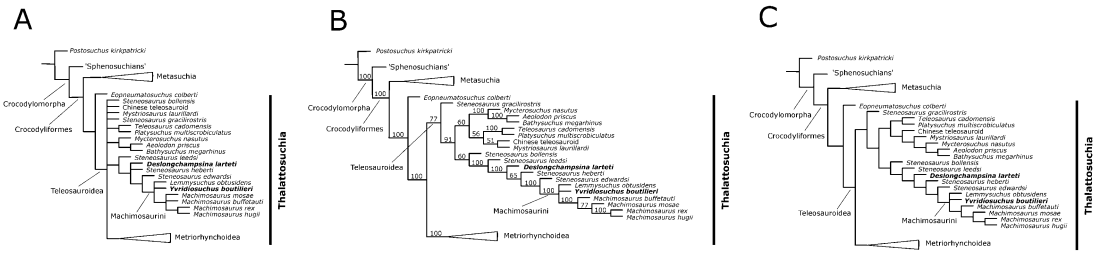


Figure 6. Results of the phylogenetic analysis, focusing on the positioning of *Yvridiosuchus boutilieri* and *Deslongchampsina larteti*. (A) Simplified strict consensus trees of the 201 most parsimonious trees (B) simplified majority rules trees and (C) simplified strict consensus tree with implied weighting (k = 12) of the 201 most parsimonious trees of Teleosauroidea within Crocodylomorpha.

Overall, the crocodylomorph interrelationships found in our analysis are similar to those recovered in previous iterations of this constantly growing dataset (Ősi et al., 2018; Ristevski et al., 2018; Foffa et al., 2019; Sachs et al., in press). All phylogenetic analyses are similar concerning the following aspects:

1. The monophyly and positioning of Thalattosuchia within Crocodyliformes.
2. The separation of Thalattosuchia into two distinct clades: Teleosauroidea and Metriorhynchoidea.
3. The monophyly of Teleosauroidea.
4. Within Teleosauroidea, *S. gracilirostris* is the likely basal-most species, with two subclades being recovered: (1) a group of poorly known taxa (e.g. Platysuchus, *Mycterosuchus*, *Aeolodon* and *Teleosaurus*) that are predominately longirostrine, and (2) the typical '*Steneosaurus*' group (e.g. *S. leedsi*, *S. edwardsi*), including the monophyletic tribe Machimosaurini (e.g. *Lemmysuchus* and *Machimosaurus*).

5. In Metriorhynchoidea, *Pelagosaurus typus* Bronn, 1841 is recovered as the basal-most metriorhynchoid and the following groups are monophyletic: Metriorhynchidae, Metriorhynchinae, Rhacheosaurini, Geosaurinae and Geosaurini.

DISCUSSION

1.1 *Deslongchampsina larteti compared to other teleosauroids*

Deslongchampsina larteti shares a number of characteristics with other teleosauroids, most notably with a handful of typical '*Steneosaurus*' taxa such as *S. heberti* (MNHN.F 1890-13), *S. leedsi* (NHMUK PV R 3806) and *S. edwardsi* (NHMUK PV R 3701, PETMG R178) (see Table 1). *Deslongchampsina larteti* (OUMNH J.29851), *S. heberti* (MNHN.F 1890-13), *S. leedsi* (NHMUK PV R 3806) and *S. edwardsi* (NHMUK PV R 3701, PETMG R178) differ from members of Machimosaurini (i.e. *Yvridiosuchus*, *Lemmysuchus* and *Machimosaurus*) in the following characters:

1. The cranium (e.g. *D. larteti* OUMNH J.29851) has a slightly proportionally longer snout (66%) than members of Machimosaurini such as *Y. boutilieri* (63%; OUMNH J.29850), *L. obtusidens* (61%) and *Mac. buffetauti* (59.6%; SMNS 91415, Young et al., 2014a).
2. There is a single parallel line of small neurovascular foramina on the lateral premaxillae, maxillae and dentaries. Taxa within Machimosaurini (e.g. *Y. boutilieri* OUMNH J.29850, *L. obtusidens* NHMUK PV R 3168, *Mac. buffetauti* SMNS 91415) have two lines of larger, irregularly shaped neurovascular foramina, as well as a general clustering of foramina around the lateral margins of the external nares (Fig. 7).
3. The palatine anterior margin (e.g. *D. larteti* OUMNH J.29851, *S. leedsi* NHMUK PV R 3806) terminates posterior to the 20th maxillary alveoli. In Machimosaurini, the palatine anterior margin terminates either level to the 15th to 19th maxillary alveoli (e.g. *Y. boutilieri* OUMNH J.1403) or 11th to 14th maxillary alveoli (e.g. *Mac. buffetauti* SMNS 91415).

4. The supratemporal fenestrae are subrectangular in shape (e.g. *D. larteti* OUMNH J.29851, *S. leedsi* NHMUK PV R 3806), whereas in Machimosaurini (e.g. *Y. boutilieri* OUMNH J.29850, *L. obtusidens* NHMUK PV R 3168, *Mac. buffetauti* SMNS 91415, *Mac. mosae* IRSNB cast; Hua, 1999; Young et al., 2014a) they are parallelogram-shaped.
5. Reception pits are only visible in the anterior-half of the maxillae (e.g. *D. larteti* OUMNH J.29851, *S. edwardsi* NHMUK PV R 3701, '*S. brevior*' NHMUK PV OR 14781, *S. heberti* MNHN.F 1890-13), whereas in Machimosaurini the reception pits are deep and visible until the posterior-most maxillae (e.g. *Y. boutilieri* OUMNH J.1401, OUMNH J.29850, *L. obtusidens* NHMUK PV R 3168, LPP.M.21, *Mac. buffetauti* SMNS 91415).
6. The teeth have pointed apices (e.g. *D. larteti* OUMNH J.29851, *S. heberti* MNHN.F 1890-13), whereas in Machimosaurini the apices are blunt and rounded (e.g. *Y. boutilieri* OUMNH J.29850, *L. obtusidens* NHMUK PV R 3168, *Mac. buffetauti* SMNS 91415, *Mac. mosae* [Hua, 1999], *Mac. hugii* MG-8730–1, *Mac. rex* ONM NG 1–25; Fig. 8).
7. The teeth have slight curvature throughout the entire dentition series (e.g. *D. larteti* OUMNH J.29851, *S. edwardsi* NHMUK PV R 3701), whereas in Machimosaurini (e.g. *Y. boutilieri* OUMNH J.29850, *L. obtusidens* NHMUK PV R 3168, *Mac. buffetauti* SMNS 91415, *Mac. mosae* [Hua, 1999], *Mac. hugii* MG-8730–1, *Mac. rex* ONM NG 1–25) at least the posterior teeth crowns are not curved (Fig. 8).
8. The teeth lack an apical macroscopic anastomosing enamel ornamentation pattern (e.g. *D. larteti* OUMNH J.29851, *S. edwardsi* PETMG R178, *S. heberti* MNHN.F 1890-13), whereas this pattern is present in all Machimosaurini teeth (e.g. *Y. boutilieri* OUMNH J.29850, *L. obtusidens* NHMUK PV R 3168, *Mac. buffetauti* SMNS 91415, *Mac. hugii* MG-8730–1, *Mac. rex* ONM NG 1–25; Fig. 8).

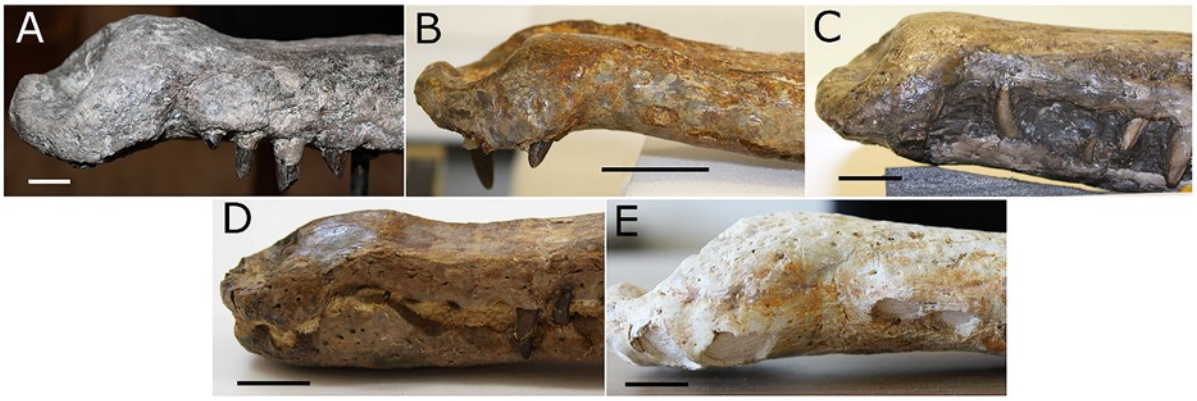


Figure 7. Comparative plate of the neurovascular foramina of the premaxilla and anterior maxilla in: (A) *Steneosaurus heberti* (MNHN.F 1890-13); (B) *Deslongchampsina larteti* (OUMNH J.29851); (C) '*Steneosaurus brevior*' (NHMUK PV OR 14781); (D) *Yvridiosuchus boutilieri* (OUMNH J.29850); and (E) *Lemmysuchus obtusidens* (LPP.M.21). All specimens in left lateral view. Scale bars: 1 cm.

Table 1. Comparison of cranial characters between *Steneosaurus leedsi*, *Steneosaurus heberti*, *Deslongchampsina larteti*, *Yvridiosuchus boutilieri*, *Lemmysuchus obtusidens* and *Machimosaurus* sp.

TAXA	Snout elongation	Orbits	Antorbital fenestrae	Suprate mporal fenestrae	Premaxillary constriction	Neurovascular foraminae	Dentition
Steneosaurus leedsi (NHMUK PV R 3806)	Longirostrine	Ellipsoid	Present - small	Sub-rectangular	Constricted	Small; single line	Teeth small, slender; pointed apices; mediolaterally compressed; no anastomosing
Steneosaurus heberti (MNHN.F.1890-13)	Longirostrine	Ellipsoid	Absent	Sub-rectangular	Constricted	Relatively small; single line	Teeth large, slender; pointed apices, mediolaterally compressed; no anastomosing
Deslongchampsina larteti (OUMNH J.29851)	Longirostrine	Ellipsoid	Present – large	Sub-rectangular	Poorly constricted	Relatively small; single line	Teeth large, robust; pointed apices; no mediolateral compression; no anastomosing
Yvridiosuchus boutilieri (OUMNH J.1401, OUMNH J.29850)	Longirostrine/ mesorostrine	Subcircular	Absent	Parallelogram	Constricted	Large, numerous; two parallel lines and clustering	Teeth large, robust, conical; blunt apices; no mediolateral compression; anastomosing

Lemmysuchus obtusidens (NHMUK PV R 3168)	Mesorostrine	Circular	Absent	Parallelogram	Constricted	Small, numerous; two parallel lines and some clustering	Teeth large, robust, conical; blunt apices; no mediolateral compression; anastomosing
Machimosaurus (SMNS 91415; Young et al. 2014)	Mesorostrine	Circular	Absent	Parallelogram	Constricted	Small, numerous; two parallel lines and some clustering	Teeth large, robust, conical; blunt apices; no mediolateral compression; anastomosing

In addition, *D. larteti* also shares one characteristic feature with *S. edwardsi* (e.g. NHMUK PV R 2865, PETMG R178): robust, pointed teeth with no mediolateral compression (differing from most non-machimosaurin teleosauroids, e.g. *S. leedsi* NHMUK PV R 3806; *Ae. priscus* MNHN.F.CNJ 78; *S. heberti* MNHN.F 1890-13) and no anastomosing pattern (differing from Machimosaurini, e.g. *Y. boutilieri* OUMNH J.29850; *L. obtusidens* NHMUK PV R 3168; *Mac. buffetauti* SMNS 91415; Fig. 8).

In the strict consensus topology (Fig. 6A), *D. larteti* is recovered in a polytomy with *S. heberti* (e.g. MNHN.F 1890-13) and the *S. edwardsi* + Machimosaurini clade. However, *D. larteti* differs from *S. heberti* (MNHN.F. 1890-13) in a number of features:

1. In *D. larteti* (OUMNH J.29851), the premaxillae are relatively dorsoventrally short and poorly constricted posteriorly, whereas in *S. heberti* (MNHN.F 1890-13) the premaxillae are dorsoventrally tall and posteriorly strongly constricted (Fig. 9A, E).
2. In *D. larteti* (OUMNH J.29851), a midline cavity is present and the nasals gently slope anteroventrally, whereas in *S. heberti* (MNHN.F 1890-13) the cavity is absent, and the nasals are flat and do not slope ventroanteriorly.
3. In *D. larteti* (OUMNH J.29851), large antorbital fenestrae are present, whereas they are absent in *S. heberti* (MNHN.F 1890-13; Fig. 10B, D).
4. The occipital tuberosities are smaller and more reduced in *D. larteti* (OUMNH J.29851), whereas in *S. heberti* (MNHN.F 1890-13) the tuberosities are large and bulbous.
5. The teeth in *D. larteti* (OUMNH J.29851) are not mediolaterally compressed, while in *S. heberti* (MNHN.F 1890-13) they are (Fig. 8A–B).

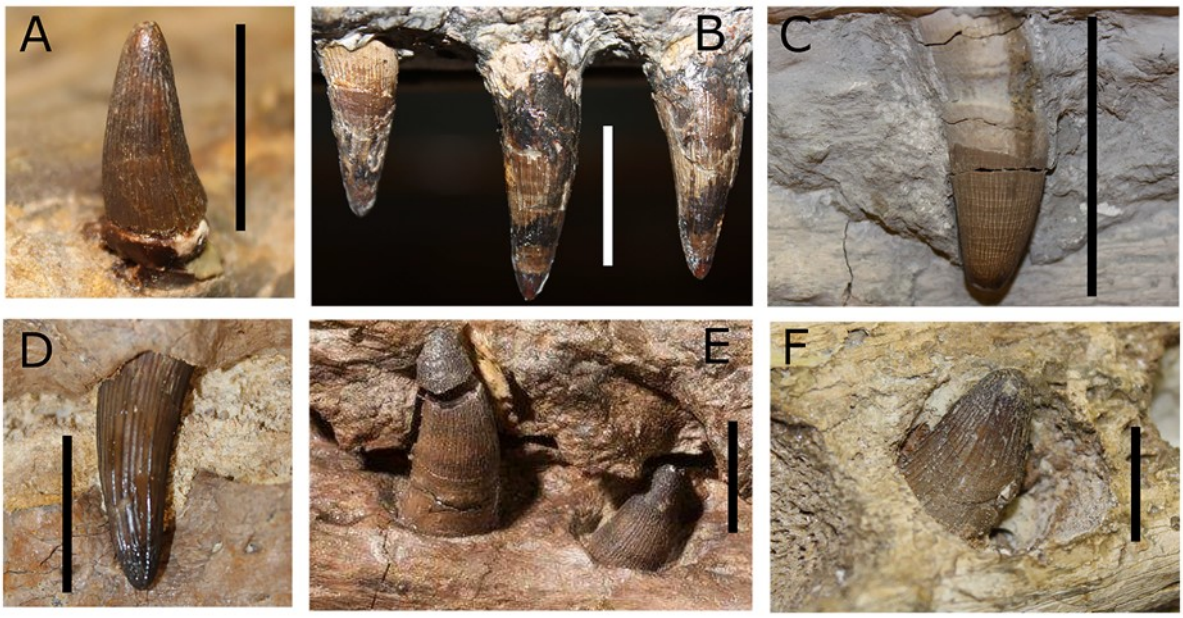


Figure 8. Comparative plate of the tooth morphology in: (A) *Deslongchampsina larteti* (OUMNH J.29851); (B) *Steneosaurus heberti* (MNHN.F 1890-13); (C) *Steneosaurus edwardsi* (PETMG R178); (D) *Yvridiosuchus boutilieri* (OUMNH J.29850); (E) *Lemmysuchus obtusidens* (NHMUK PV R 3168); and (F) *Machimosaurus buffetauti* (SMNS 91415). Scale bars: 1 cm.

Deslongchampsina larteti also shares one key character with *S. gracilirostris* (NHMUK PV OR 14792): a pair of large, anteroposteriorly elongated antorbital fenestrae that are nearly half the diameter of the orbit (Fig. 10A–B). This differs from other teleosauroids that either have smaller, subcircular antorbital fenestrae (e.g. *Y. boutilieri* OUMNH J.29850; *S. bollensis* SMNS 51753; *Myc. nasutus* NHMUK PV R 2617) or none at all (e.g. *S. heberti* MNHN.F 1890-13; *S. edwardsi* PETMG R178; *L. obtusidens* PETMG R39; *Mac. buffetauti* SMNS 91415; Fig. 10).

1.2 *Yvridiosuchus boutilieri compared to other teleosauroids*

Yvridiosuchus boutilieri has a mosaic combination of characteristics, with some seen in Machimosaurini (most notably *Lemmysuchus*) and others in non-machimosaurin teleosauroids (e.g. '*S. brevior*' NHMUK PV OR 14781). Non-machimosaurin teleosauroid features seen in *Y. boutilieri* include:

2 The rostral height and width are subequal, similar to *L. obtusidens* (NHMUK PV R 3168) and all other non-machimosaurins (e.g. *S. heberti*

MNHN.F 1890-13; *Ae. priscus* MNHN.F.CNJ 78; the Chinese teleosauroid IVPP V 10098; *S. edwardsi* NHMUK PV R 2865).

3 There is an expanded network of neurovascular openings on the dorsal, lateral and ventral surfaces of the rostrum mandible, as in '*S. brevior*' (NHMUK PV OR 14781).

4 The antorbital fenestrae are present, as in *D. larteti* (OUMNH J.29851), *S. leedsi* (NHMUK PV R 3806), *S. bollensis* (SMNS 51753, 51957), *Myc. nasutus* (NHMUK PV R 2617, CAMSM J.1420), '*S. brevior*' (NHMUK PV OR 14781), the Chinese teleosauroid (IVPP V 10098), *Pl. multiscrobiculatus* (SMNS 9930) and *Teleosaurus cadomensis* Lamouroux, 1820 (MNHN AC 8746; Westphal 1962).

5 The frontal is subequal with orbital width, as in *D. larteti* (OUMNH J.29851), *S. heberti* (MNHN.F 1890-13), *Myc. nasutus* (NHMUK PV R 2617) and the Chinese teleosauroid (IVPP V 10098).

More importantly, *Y. boutilieri* (OUMNH J.1401, OUMNH J.29850) displays multiple features observed in Machimosaurini, and shares the following characters with *L. obtusidens* (NHMUK PV R 3168) that differ from *Machimosaurus* (i.e. *Machimosaurus* autapomorphies) (see Table 2):

1 There are four premaxillary alveolar pairs in *Y. boutilieri* (OUMNH J.1401) and *L. obtusidens* (NHMUK PV R 3168); *Machimosaurus* sp. have three premaxillary alveolar pairs (e.g. SMNS 91415; Young et al., 2014a).

2 There are 29 or more maxillary alveolar pairs in both *Y. boutilieri* (OUMNH J.29850) and *L. obtusidens* (NHMUK PV R 3168); *Mac. buffetauti* has approximately 21–28 maxillary alveolar pairs and *Mac. mosae* (Young et al., 2014a) has approximately 17–20 alveolar pairs.

3 There are at least 29 alveoli per dentary in *Y. boutilieri* (OUMNH J.29850) and *L. obtusidens* (NHMUK PV R 3168), whereas *Machimosaurus* sp. have approximately 19–25 alveoli per dentary.

4 All teeth have carinae in *Y. boutilieri* (OUMNH J.29850) and *L. obtusidens* (NHMUK PV R 3168), whereas the presence of carinae is variable in *Machimosaurus* sp.

5 The rostrum is less mediolaterally broad in *Y. boutilieri* (OUMNH J.29850) and *L. obtusidens* (NHMUK PV R 3168) than in *Machimosaurus* sp. (e.g. *Mac. buffetauti* SMNS 91415; *Mac. mosae* IRSNB cast).

6 In *Y. boutilieri* (OUMNH J.29850) and *L. obtusidens* (NHMUK PV R 3168), the medial hemicondyle of the quadrate is smaller than the lateral hemicondyle, whereas in *Machimosaurus* sp. (e.g. *Mac. hugii* MG-8730–2) both condyles are approximately the same size.

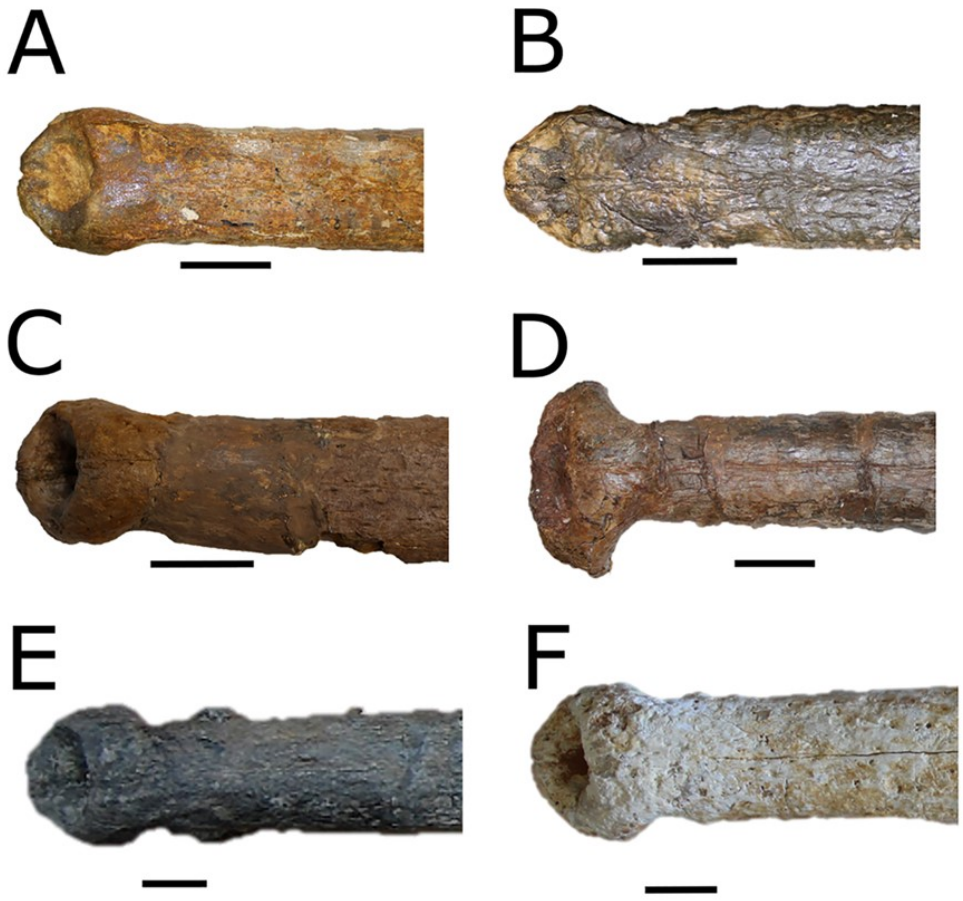


Figure 9. Comparative plate of the anterior rostrum of (A) *Deslongchampsina larteti* (OUMNH J.29851); (B) *Steneosaurus leedsi* (NHMUK PV R 3806); (C) *Yvridiosuchus boutilieri* (OUMNH J.1401); (D) the Chinese teleosauroid previously referred to as *Peipehsuchus* (IVPP V 10098); (E) *Steneosaurus heberti* (MNHN.F 1890-13); and (F) *Lemmysuchus obtusidens* (LPP.M.21). Note the lack of constriction in *D. larteti*. Scale bars: 3 cm.

Yvridiosuchus boutilieri has the following machimosaurin autapomorphies (seen in both *L. obtusidens* and *Machimosaurus* sp.):

1 Conical teeth with blunt/rounded apices (Fig. 8).

2 Tooth enamel varies along the crown (in the basal region, enamel ornamentation is composed of numerous apicobasally aligned ridges of high relief, which transition into an anastomosed pattern in the apical region).

3 Teeth have both true and false denticles.

4 Anterior-middle teeth have no more than 85° or no curvature.

5 Pronounced socket-like reception pits along the entirety of the maxilla and dentaries (excluding the posterior-most areas) for the opposing tooth row.

6 Large neurovascular foramina present in two parallel lines along the lateral margins of the premaxillae, maxillae and dentaries (Fig. 7).

7 Parallelogram-shaped supratemporal fenestrae in dorsal view.

Table 2. Defining characters within the tribe Machimosaurini (including *Yvridiosuchus*, *Lemmysuchus* and *Machimosaurus*).

Machimosaurini characters	***Machimosaurus* characters**	***Machimosaurus* + *Lemmysuchus* characters**	***Machimosaurus* + *Yvridiosuchus* characters**
1. Conical teeth with blunt/rounded apices	1.Three premaxillary alveolar pairs	1. Absence of antorbital fenestrae	1. Nasals slightly convex and unfused with evident midline concavity
2. Tooth enamel varies along the crown, with present anastomosing pattern	2. 17-20 or 21-28 alveoli per maxilla (dependent on species)	2. Circular orbits	2. Reduced nuchal crest
3. Teeth have true and false denticles	3. 19-25 alveoli per dentary	3. Blunt ischial blade than other teleosauroids (e.g. Steneosaurus leedsi NHMUK PV R 3806) with a sub-square posteroventral margin	
4. Ratio of crown apicobasal height to basal transverse width as low as 1.8 in posterior teeth	4. Presence of carinae is variable	4. Three sacral vertebrae	
5. Anterior-middle teeth have no curvature	5. Broadly mesorostrine skull	5. Femoral medial condyle larger than lateral condyle	
6. Pronounced socket-like reception pits along the entirety of the maxilla and dentaries	6. Lateral and medial hemicondyles of the quadrate are relatively the same size		

7. Large neurovascular foramina present in two parallel lines along the lateral margins of the premaxillae, maxillae and dentaries			
8. Parallelogram-shaped supratemporal fenestrae			

While our phylogenetic analyses (Fig. 6) do not resolve whether *Y. boutilieri* (OUMNH J.1401, OUMNH J.29850) and *L. obtusidens* (NHMUK PV R 3168) are sister taxa (or if one is more closely related to *Machimosaurus* than the other), these two taxa differ in a number of key characteristics:

1 The neurovascular foramina are very large, especially in the premaxillae, in *Y. boutilieri* (OUMNH J.1401, OUMNH J.29850), whereas in *L. obtusidens* (NHMUK PV R 3168, NOTNH FS3361) they are smaller. There is also a more disorganized clustering of the foramina across the premaxillae and around the lateral margins of the external nares in *Y. boutilieri* (OUMNH J.1401, OUMNH J.29850; see Fig. 7D–E).

2 Small anteroposteriorly elongated antorbital fenestrae are present in *Y. boutilieri* (OUMNH J.1401, OUMNH J.29850, OUMNH J.1403), whereas they are absent in *L. obtusidens* (NHMUK PV R 3168, LPP.M.21, PETMG R39; Fig. 10C, E).

3 In *Y. boutilieri*, there is a small midline concavity present along the posterior nasals (best seen in OUMNH J.1401), whereas *L. obtusidens* (LPP.M.21, PETMG R39) this concavity is absent.

4 The orbit is slightly more anteroposteriorly elongate in *Y. boutilieri* (OUMNH J.1401, OUMNH J.1403, OUMNH J.29850), whereas they are circular in *L. obtusidens* (LPP.M.21, NHMUK PV R 3168).

5 The frontal width is subequal to the orbital width in *Y. boutilieri* (OUMNH J.1401, OUMNH J.29850), whereas in *L. obtusidens* (LPP.M.21) the frontal width is broader (both *Mac. hugii* and *Mac. rex* (see: Young et al., 2014a; Fanti et al., 2016) also share the same state as *Y. boutilieri*).

6 In *Y. boutilieri* (OUMNH J.1403), the anterior palatines are U-shaped, whereas in *L. obtusidens* (LPP.M.21) they are V-shaped.

7 In *Y. boutilieri* (OUMNH J.29850), the retroarticular process of the mandible is narrower than the glenoid fossa, whereas in *L. obtusidens* (NHMUK PV R 3168) the glenoid fossa is narrower than the retroarticular process.

8 In *Y. boutilieri* (OUMNH J.29850, OUMNH J.1403), the keeled carinae on the apex of the teeth are faint, as in *Mac. buffetauti* (SMNS 91415), *Mac. hugii* (MG- 8730–1) and *Mac. rex* (OMN NG 1–25), whereas the teeth of *L. obtusidens* (NHMUK PV R 3168) have large, noticeably keeled carinae.

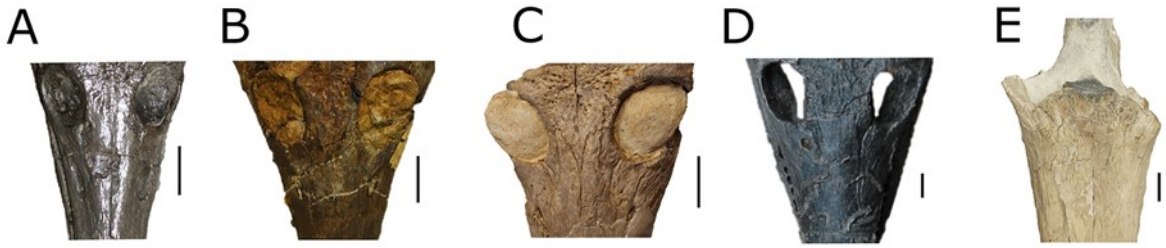


Figure 10. Comparative plate of the presence of absence of antorbital fenestrae in: (A) *Steneosaurus gracilirostris* (NHMUK PV OR 14792); (B) *Deslongchampsina larteti* (OUMNH J.29851); (C) *Yvridiosuchus boutilieri* (OUMNH J.1401); (D) *Steneosaurus heberti* (MNHN.F 1890-13); and (E) *Lemmysuchus obtusidens* (PETMG R39). Note that *S. heberti* and *L. obtusidens* lack antorbital fenestrae, and that the fenestra is small in Y. boutilieri. Scale bars: 4 cm.

Currently, it is unclear whether *Y. boutilieri* or *L. obtusidens* is the sister-taxon to *Machimosaurus*. The lack of post-cranial remains for *Y. boutilieri* is undoubtedly one of the primary reasons the three machimosaurin genera are recovered as a polytomy, especially given how apomorphic the post-cranial skeleton of machimosaurins are (see: Young et al., 2014a; Johnson et al., 2017). As noted above, both *Y. boutilieri* and *L. obtusidens* lack numerous *Machimosaurus* autapomorphies, but both have some characters in common with *Machimosaurus* and not each other (see Table 2). This character conflict is interesting, as it hints that there could be more morphological variation in Machimosaurini than currently realized.

As mentioned previously, Hulke (1877) described and figured a new species, *S. stephani* (NHMUK PV OR 49126) and compared it with ‘D.’ *larteti* and ‘*Y.*’ *boutilieri*, as well as *S. megistorhynchus*. While Vignaud (1995) listed this species as being synonymous with *Y. boutilieri*, NHMUK PV OR 49126

lacks the parallelogram-shaped supratemporal fenestrae observed in all Machimosaurini (e.g. *Y. boutilieri* OUMNH J.29850; *L. obtusidens* NHMUK PV R 3168; *Mac. buffetauti* SMNS 91415; *Mac. mosae* IRSNB cast). *Steneosaurus stephani* (NHMUK PV OR 49126) also differs from *Y. boutilieri* (OUMNH J.29850) in having:

1 A very broad frontal with a small, mediolaterally broad anterior process [the frontal in *Y. boutilieri* (OUMNH J.29850) is more medially constricted and the anterior process is thin and elongated; Fig. 11A–B).
2 A gentle dorsoposterior inclination of the retroarticular process [in *Y. boutilieri* (OUMNH J.29850) the retroarticular process is sharply dorsoposteriorly inclined].
3 Small postorbitals (these are much larger in *Y. boutilieri* OUMNH J.29850; Fig. 11A–B).
4 No evidence of antorbital fenestrae (small anteroposteriorly elongated antorbital fenestrae are present in *Y. boutilieri* OUMNH J.29850; Fig. 11A–B), although this may be due to preservation.

In addition, NHMUK PV OR 49126 differs from *D. larteti* (OUMNH J.29851) in the following ways:

1 There is no evidence of antorbital fenestrae in NHMUK PV OR 49126, as opposed to the large, anteroposteriorly elongated antorbital fenestrae in *D. larteti* (OUMNH J.29851), although this may be a preservation issue (see above).
2 The anterior projection of the frontal is much shorter and broader in NHMUK PV OR 49126 than in *D. larteti* (OUMNH J.29851; Fig. 11A, C).
3 NHMUK PV OR 49126 has circular orbits, whereas *D. larteti* (OUMNH J.29851) has oval-shaped orbits (Fig. 11A, C).
4 NHMUK PV OR 49126 has relatively large basituberosities, as opposed to *D. larteti* (OUMNH J.29851) where the basituberosities are reduced.

Furthermore, neither the rostrum nor associated teeth are preserved in NHMUK PV OR 49126, so we cannot assess whether it has critical machimosaurin characters (e.g. large and numerous neurovascular foramina or blunt tooth crowns with anastomosed apical enamel ornamentation).

Therefore, we currently agree with Hulke's (1877) diagnosis and provisionally retain NHMUK PV OR 49126 as a distinct taxon, *S. stephani*.

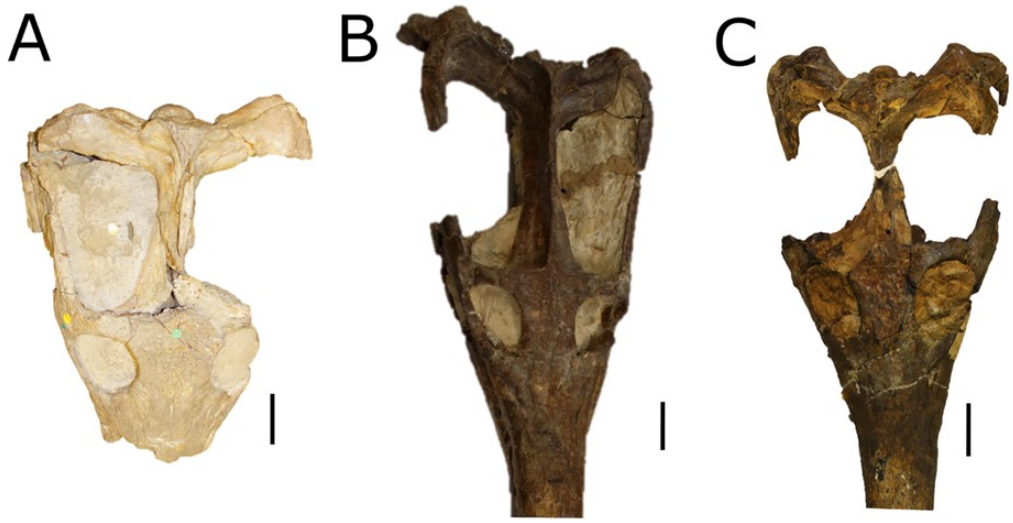


Figure 11. Comparative plate of (A) *Steneosaurus stephani* (NHMUK PV OR 49126); (B) *Yvridiosuchus boutilieri* (OUMNH J.29850); and (C) *Deslongchampsina larteti* (OUMNH J.29851). Scale bars: 4 cm.

1.3 *Bathonian teleosauroids of Northern Africa*

As mentioned previously, Jouve et al. (2016) described fragmentary indeterminate machimosaurin material (MHNM.I ss02) from Morocco. This material included a strongly abraded anterior portion of the dentary, with one in situ tooth. Four alveoli are preserved on the left side and three alveoli on the right. The anterior dentaries and tooth morphology in MHNM.I ss02 (e.g. blunt apex, anastomosing pattern, false denticles) is similar to that seen in all members of Machimosaurini (*Yvridiosuchus*, *Lemmysuchus* and *Machimosaurus*), but there are no distinguishing features that specifically refer it to *Yvridiosuchus* (e.g. OUMNH J.1404). Therefore, MHNM.I ss02 should currently remain as Machimosaurini indeterminate.

Jouve et al. (2016) also mentioned small fragments of Moroccan material (MHNM.I ss01) that he attributed to Teleosauroidea indeterminate. These include a small section of skull (including the maxilla, lacrimal and possible jugal) and posterior mandible (which includes eight alveoli and

sections of the dentary and palatine). In the mandibular piece, in lateral view, there appears to be very slight reception pits, which are seen in the posterior part of the dentary in *Y. boutilieri* (e.g. OUMNG J.29850), but as there is currently no substantial mandibular material referred to *Deslongchampsina* it is difficult to make a comparison. Jouve et al. (2016) suggested that MHNM.I ss01 might belong to a longirostrine, narrow-snouted taxon, which would tentatively suggest *Deslongchampsina* (e.g. OUMNH J.29851) rather than *Yvridiosuchus* (e.g. OUMNH J.1401). However, this material is much too fragmentary, in particular the skull fragment, to confidently refer it to a genus, and should currently remain as Teleosauroidea indeterminate.

In addition, Fara et al. (2002) briefly described a fragmentary portion of premaxilla, KE-222-1, from the Techout Formation (Bathonian) and attributed it to *Steneosaurus* sp. The associated tooth is described as gracile, yet conical. However, the specimen figures are too dark to confidently identify KE-222-1 as either *Yvridiosuchus* or *Deslongchampsina*. Therefore, we attribute KE-222-1 to Teleosauroidea indeterminate.

1.4 *Morphotypes from the Bathonian of the UK*

We have established, primarily based on tooth and cranial morphology, that there were two distinct morphotypes present during the Bathonian of England, both preserved in GOG: a durophagous/ macrophagous morphotype (*Y. boutilieri*) and an intermediate mesorostrine form (*D. larteti*) that falls between piscivorous and macrophagous morphologies (e.g. Foffa et al., 2018a). However, there is also the presence of a third morphotype within the GOG, *S. megistorhynchus* (OUMNH J.1414; Fig. 12A). A longirostrine lower jaw, with two erupting teeth, represents this taxon. *Steneosaurus megistorhynchus* (OUMNH J.1414) differs from *D. larteti* (OUMNH J.29851) and *Y. boutilieri* (OUMNH J.29850) in the following:

1 The overall construction of OUMNH J.1414 is much more slender and gracile compared to *Y. boutilieri* (OUMNH J.29850), as well as *D. larteti* (OUMNH J.29851).

2 In OUMNH J.1414, the teeth are pointed, small, slender and mediolaterally compressed. In *Y. boutilieri* (OUMNH J.29850), the teeth

are conical, blunt and anastomosed, and in *D. larteti* (OUMNH J.29851), they are robust and not mediolaterally compressed.

3 In OUMNH J.1414, the carinae on the teeth are small and faint, whereas in *Y. boutilieri* (OUMNH J.29850), the carinae are pronounced and noticeable.

4 The anterior reception pits of the mandible are small and nearly unnoticeable in OUMNH J.1414, whereas in *Y. boutilieri* (OUMNH J.29850) the reception pits are deep and extensive throughout the mandible.

5 The angular is gently dorsoposteriorly curved in OUMNH J.1414, as opposed to *Y. boutilieri* (OUMNH J.29850) in which the angular is sharply dorsoposteriorly curved.

Overall, *S. megistorhynchus* is more similar in form to *S. leedsi* (e.g. NHMUK PV R 3320, NHMUK PV R 3806) than *D. larteti* (OUMNH J.29851) or *Y. boutilieri* (OUMNH J.29850); due to its slender build and teeth, *S. megistorhynchus* (OUMNH J.1414) might possibly have been a piscivore and/or teuthophage. In addition, Lydekker (1888) mentions the presence of *T. cadomensis* from Fuller's Earth (Bathonian) of Calvados, France (the area where the holotype of *D. larteti* was found). Known from an array of specimens [e.g. NHMUK PV R 119a (Fig. 12B), NHMUK PV R 880a, NHMUK PV OR 32584, NHMUK PV OR 32588, NHMUK PV OR 32591], *T. cadomensis* is a longirostrine, heavily armoured, more terrestrial form. In sum, we can now recognize four distinct ecomorphotypes living at the same time in the same geographical area, but occupying different niches.

An interesting observation to note is that while Sub-Boreal teleosauroid ecosystems of England change in diversity through time, the ecological structuring (which has briefly been explored; see: Hua, 1997; Hua & Buffetaut, 1997; Foffa et al., 2018a), in particular during the Bathonian–Callovian, remains relatively similar. Prior to the Bathonian, in the Toarcian Whitby Mudstone Formation of England, '*S. brevior*' represents a mesorostrine generalist, *S. bollensis* a longirostrine generalist and *S. gracilirostris* a longirostrine specialist with lateral orbits (likely a piscivore) (Westphal, 1962). In addition, the continental Toarcian deposits of

Luxembourg and Germany had a slightly different diversity: a mesorostrine generalist ectomorph ('*S. brevior*'), a longirostrine generalist ectomorph (*S. bollensis*) and a heavily armoured, more terrestrial ecomorph (*Pl. multiscrobiculatus*) (Westphal, 1962; Johnson et al., 2018; Sachs et al., in press).

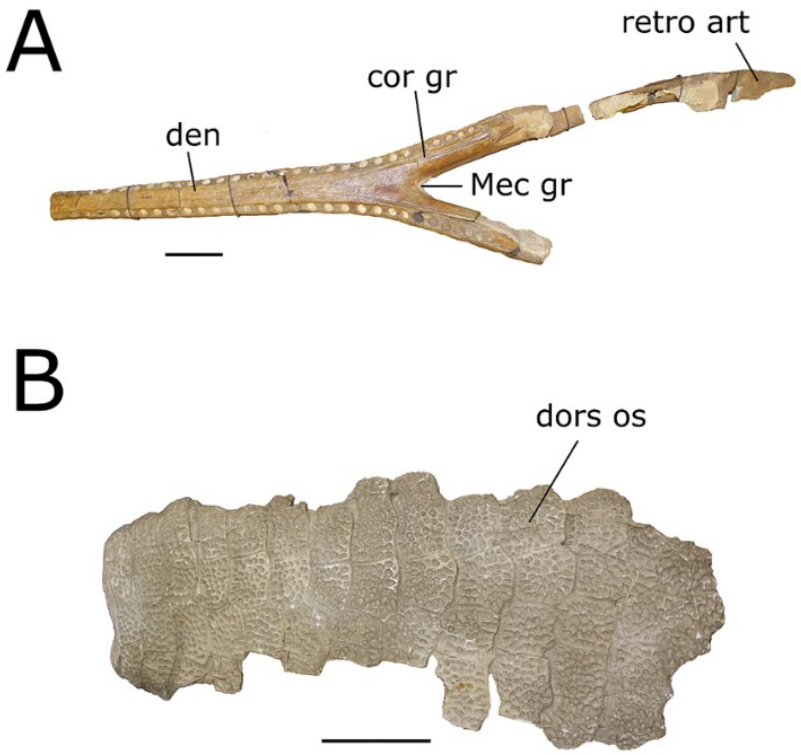


Figure 12. Photographs of (A) *Steneosaurus megistorhynchus* (Eudes-Deslongchamps, 1866a), OUMNH J.1414 and (B) *Teleosaurus cadomensis* (Lamouroux, 1820), NHMUK PV R 119a. Refer to the main text for the abbreviation list. Scale bars: 5 cm.

By the Bathonian (Cornbrash Formation), all teleosauroids had dorsal/dorsolaterally oriented orbits, so the niche held by *S. gracilirostris* was apparently lost. However, a new ecomorphotype evolved: a mesorostrine macrophage/durophage (represented by *Y. boutilieri*). In the Bathonian, the heavily armoured, more terrestrial longirostrine ecomorphotype was filled by *T. cadomensis*, *D. larteti* filled the role of mesorostrine generalist and *S. megistorhynchus* replaced *S. bollensis* as the longirostrine generalist. In the Middle Callovian (Oxford Clay Formation), *Y. boutilieri* gave way to *L. obtusidens* as the mesorostrine macrophage/durophage form; *S. edwardsi* replaced *D. larteti* as the mesorostrine generalist (and is currently the most

commonly known teleosauroid from the Oxford Clay); *S. leedsi* represented the longirostrine generalist ecomorph; and *Myc. nasutus* filled the more terrestrial, longirostrine role. In the Late Jurassic, during the Kimmeridgian–Tithonian, macrophagous/ durophagous ecomorphs were the most dominant form of teleosauroids, with *Mac. mosae*, *Mac. hugii* and *Mac. buffetauti* occupying these roles, and the rarer, mesorostrine generalist form was represented by *Steneosaurus bouchardi* Sauvage, 1872. Interestingly, there was also a shift to more pelagic forms, which included taxa such as *Ae. priscus*, *B. megarhinus* (Foffa et al., 2019) and *Steneosaurus jugleri* von Meyer, 1845. In addition, the heavily armoured, more terrestrial and longirostrine generalist ecomorphs vanished.

The Bathonian-aged *Y. boutilieri* also represents the current oldest known member of Machimosaurini from England, and the current oldest substantial machimosaurin material from anywhere in the world. This shows that, while rare, machimosaurins were already an important component of Bathonian ecosystems and had already evolved key characteristic machimosaurin features earlier than originally thought (i.e. blunt anastomosing teeth, parallelogram-shaped supratemporal fenestrae, deep reception pits).

CONCLUSIONS

While '*S.*' *larteti* and '*S.*' *boutilieri* are both morphologically and historically important teleosauroid taxa, little work has been done on them since the mid-20th century. Here we re-describe one complete specimen of '*S.*' *larteti*, OUMNH J.29851, consisting of a nearly complete skull, and use it to establish a new genus, *Deslongchampsina*. We then re-describe four specimens of '*S.*' *boutilieri* (the designated neotype consisting of a partial skull; one complete skull and nearly complete mandible; one nearly complete skull; and one partial mandible) and designate a new genus, *Yvridiosuchus*. *Yvridiosuchus* and *Deslongchampsina* represent two distinct Bathonian morphotypes (along with *S. megistorhynchus* as a third morphotype) in the Cornbrash Formation of England, which are joined by a fourth coeval

morphotype from Fuller's Earth of France (*T. cadomensis*): *Yvridiosuchus* was a mesorostrine macrophagous form, *S. megistorhynchus* a longirostrine generalist/piscivorous form, *Deslongchampsina* an intermediate, mesorostrine generalist form and *Teleosaurus* a more terrestrial longirostrine ecomorphotype. In addition, many of the defining characteristics of Machimosaurini had already evolved by the Bathonian, suggesting that the transition from a generalist diet to more macrophagous/ durophagous one began prior to the Bathonian. This is supported by the broad distribution of machimosaurins in the Bathonian, known from the Sub-Boreal seaways north of the Tethys (England and France) and southern shore of the Tethys/Proto-Atlantic (Morocco). The poor fossil record of teleosauroids in the Aalenian and Bajocian hampers our understanding of when this major evolutionary innovation began, and when members of Machimosaurini achieved their circum-Tethys distribution.

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CHAPTER IV:

The Phylogeny of Teleosauroidea (Crocodylomorpha, Thalattosuchia): Methods, Character Descriptions, Taxonomy and Phylogenetic Results

"Give me a 15-ft. crocodile any day over a bee."

-Bindi Irwin

PREFACE: I was responsible for all the work carried out in this chapter, including all the analyses, new character diagnoses and descriptions, and updated taxonomic revision and clades. The corresponding supplementary files are included in Appendix S2 of this manuscript and include:

APPENDIX S2

S2.1: Short_Character_List.doc

S2.2: OSM_HY_Matrix.doc

S2.3: HY_dataset_final_July.txt (formatted from the Excel spreadsheet)

INTRODUCTION

Teleosauroid crocodylomorphs – distant extinct relatives of modern crocodilians (which include alligators, crocodiles, caimans and gavials) – were a near-globally distributed clade that frequented shallow marine, brackish, freshwater and deepwater ecosystems throughout the Jurassic (Buffetaut 1982; Hua & Buffetaut, 1997; Hua 1999; Foffa et al. 2015, 2019; Johnson et al. 2015; Martin et al. 2016; Johnson et al. 2017, 2019). They have frequently been regarded as marine analogues of extant gavials, as the majority of species had an elongate and tubular snout, high tooth count and dorsally directed orbits, suggesting a feeding style of catching small, fast-moving prey (Andrews 1909, 1913; Buffetaut 1982; Hua 1999; Young et al. 2014a).

While their morphology has been well documented throughout the 19th Century to present (e.g. Eudes-Deslongchamps, 1867-69; Westphal, 1961, 1962; Andrews, 1909, 1913; Young et al., 2014a; Johnson et al., 2017, 2019; Foffa et al., 2019; Sachs et al., 2019b), the phylogenetics (evolutionary relationships) of these crocodylomorphs is poorly understood and little

studied. This is problematic, as phylogenies are crucial when analysing relationships among members within a group and tracking evolutionary changes throughout time (Purvis et al., 2005; Mishra & Thines, 2014). One of the major problems for this phylogenetic ambiguity within teleosauroids is the lumping of the genus '*Steneosaurus*', which has served as a wastebasket taxon for a multitude of species. The validity of this genus has only recently been called into question; the type specimen, *Steneosaurus rostromajor* (housed at the MNHN in Paris, France), has rarely been referenced and never figured in the literature since its preliminary descriptions by Cuvier (1800, 1808, 1812, 1824) (for more information, see Chapter VI). Another major issue is the impression, brought about and reinforced during the 19th and 20th Centuries (e.g. Andrews, 1909, 1913), that, while there are noticeable differences between the skulls, the postcranial skeleton remains largely morphologically unchanging, and therefore teleosauroids must have lived in similar habitats with a conservative body plan. However, recent studies (e.g. Young et al., 2014a; Johnson et al., 2017; Foffa et al., 2019; Martin et al., 2019) have begun to dispute this claim, showing that, in terms of postcranial anatomy and palaeoenvironment, teleosauroids were more diverse than originally thought.

Herein I present an in-depth, comprehensive phylogenetic study of Teleosauroidea, using the most recently updated crocodylomorph dataset. This chapter will: (1) review the historical background of teleosauroid phylogenetics; (2) explain the materials and phylogenetic methods used in my study; (3) list detailed descriptions and figures of new and morphologically important characters; (4) provide an up-to-date, in-depth taxonomic layout of Teleosauroidea; and (5) discuss the results of the phylogenetic analyses. The following chapter (V) will discuss teleosauroid trends throughout the entirety of their evolutionary history, based on the new phylogeny presented here.

PREVIOUS TELEOSAUROID PHYLOGENETIC ANALYSES

While descriptions of teleosauroid fossils have been prevalent since the mid-18th Century (the first teleosauroid fossil was described in a 1758 scientific journal: Chapman, 1758), interest in their phylogenetics is a relatively new area of study. While Buffetaut (1980a, 1980b) and Vignaud (1995) briefly investigated general thalattosuchian interrelationships, it was not until the early 21st Century that members of this clade were becoming incorporated into larger crocodylomorph studies. However, the majority of these phylogenetic analyses were not focused on the greater interrelationships between thalattosuchians, and usually included only one or two teleosauroid taxa. For example, Gasparini et al. (2006) only included '*Steneosaurus*' *bollensis* von Jäeger, 1828, and *Pelagosaurus typus* Bronn, 1841 (which was considered a basal teleosauroid at that time) in their analysis. This was the same seen in Pol & Gasparini (2009).

Mueller-Töwe's (2006) unpublished thesis was one of the first analyses that focused specifically on thalattosuchian phylogenetics, in particular Teleosauridae, building on a preliminary study (Mueller-Töwe, 2005). However, out of 29 taxa with 189 characters, only twelve teleosauroids were included: *Machimosaurus hugii* von Meyer, 1837; *Platysuchus multiscrobiculatus* (Berckhemer, 1929) Westphal 1961; '*Steneosaurus*' *baroni* Newton, 1983; '*S.*' *bollensis*; '*Steneosaurus*' *edwardsi* Eudes-Deslongchamps, 1868a; '*Steneosaurus*' *boutilieri* Eudes-Deslongchamps, 1868c; '*Steneosaurus brevior*' Blake, 1876; '*Steneosaurus*' *gracilirostris* Westphal, 1961; '*Steneosaurus*' *leedsi* Andrews, 1909 (incorporating *Mycterosuchus nasutus* Andrews, 1913); '*Steneosaurus*' *megarhinus* Hulke, 1871; '*Steneosaurus*' *obtusidens* Andrews, 1909; '*Steneosaurus*' (*Aeolodon*) *priscus* von Sömmerring, 1814; and *Teleosaurus cadomensis* Lamouroux, 1820. Other taxa were considered insufficient to include in the dataset, and only four teleosauroids used in the analysis were studied in-depth: *Platysuchus multiscrobiculatus*, '*Steneosaurus brevior*', '*Steneosaurus*' *bollensis* and '*Steneosaurus*' *gracilirostris* (note that Mueller-Töwe (2006) specifically focused on Toarcian species). In addition, there were no ordered or weighted characters, and multi-state characters were treated as polymorphs (Mueller-Töwe, 2006). The strict consensus results produced 123 most parsimonious trees (MPTs) with a tree length of 423, an

ensemble consistency index (CI) of 0.6312 and an ensemble retention index (RI) of 0.6549 (Fig. 1A). The teleosauroids were found to be monophyletic but with *Pelagosaurus* as the basal-most teleosauroid. The genus '*Steneosaurus*' was found to be paraphyletic and *Platysuchus* was most closely related to Machimosaurus (Fig. 1A). However, it is important to note that throughout the entirety of Mueller-Töwe (2006) there are numerous factual errors and inconsistencies, in the anatomical descriptions as well as the phylogenetic analysis and distribution and ecology interpretations.

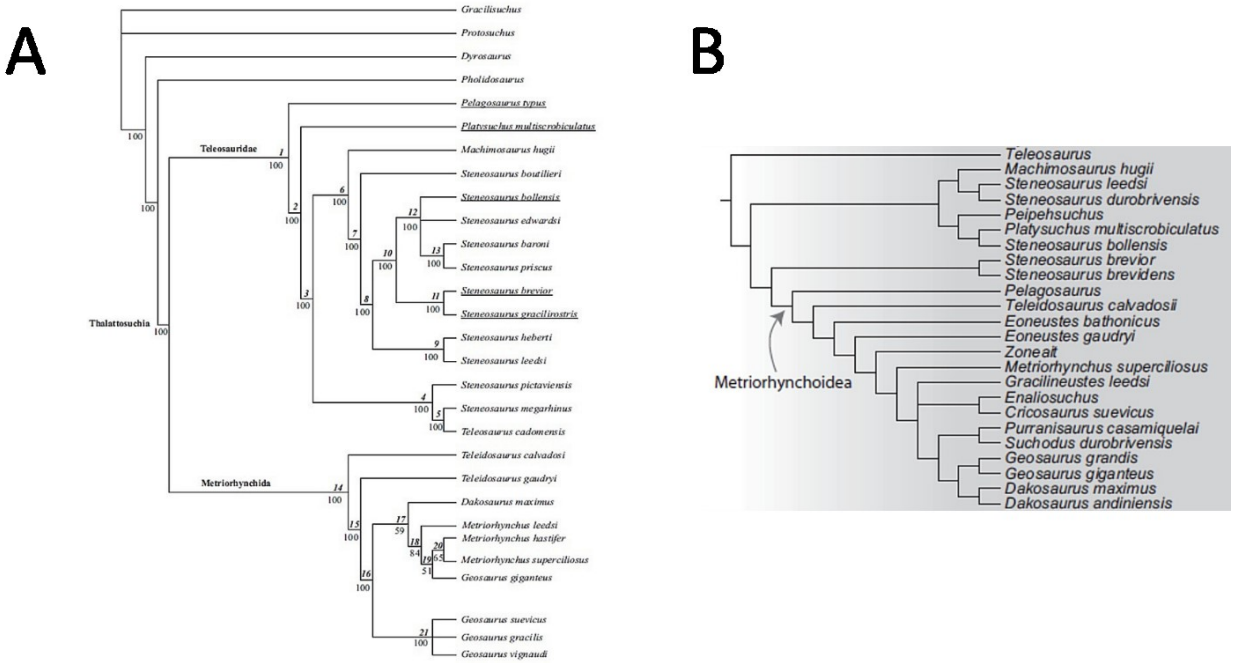


Figure 1. Results of past teleosauroid phylogenetic analyses. Taken from (A) Mueller-Töwe (2006; Figure 6.1) and (B) Wilberg (2015a; Figure 3).

When re-describing *T. cadomensis*, Jouve (2009) performed a phylogenetic analysis of 75 taxa and 343 characters, and included the teleosauroid taxa *Teleosaurus*, *Peipehsuchus teleorhinus* Young, 1948 (then thought to be a teleosauroid), '*S.*' *bollensis*, *Pelagosaurus* (still considered to be a teleosauroid by some, although there was growing anatomical support for it as a metriorhynchoid: Buffetaut, 1980a; Mercier, 1993), '*Steneosaurus*' *larteti* Eudes-Deslongchamps, 1866a and '*Mystriosaurus*' Kaup, 1834. The strict consensus results produced 67 MPTs and 1462 steps (CI: 0.28; RI: 0.66), and Metriorhynchidae nestled within the teleosauroids. Another study involved Pierce et al. (2009a) running a parsimonious analysis based off Mueller-Töwe's (2006) character matrix; however, synonymous species (e.g. '*S.*' *leedsi* and '*S.*' *megarhinus*) were combined and taxa not used in the

authors' landmark-based geometric morphometric analysis were deleted. Therefore, Pierce et al. (2009a) only included seven teleosauroids ('*Steneosaurus*' *heberti* Morel de Glasville, 1876, '*S*.' *gracilirostris* , *Pl*. *multiscrobiculatus*, *Mac. hugii*, '*S*.' *leedsi*, '*S*.' *bollensis* and '*S*. *brevior*') including *Pelagosaurus*, with *Metriorhynchus superciliosus* de Blainville, 1853 as the outgroup. This dataset produced two MPTs with 115 steps (CI: 0.621).

Bronzati et al (2012) presented an in-depth crocodylomorph study, including 19 teleosauroid species in their analysis; however, the Chinese teleosaurid (IVPP V 10098) was treated as the genus *Peipehsuchus* (now believed to be a metriorhynchoid); '*S*.' *edwardsi*, and '*Steneosaurus durobrivensis*' Andrews, 1909 (which is a junior synonym of '*S*.' *edwardsi*; see Johnson et al. 2015), were treated as separate taxa; and '*Steneosaurus pictaviensis*' Vignaud, 1998, was included (which is likely a junior synonym of '*S*.' *leedsi*; see below). Several key taxa were also absent in this analysis (e.g. *Myc nasutus*, '*S*.' *obtusidens* and *Machimosaurus mosae* Sauvage & Liénard, 1879). In addition, Bronzati et al. (2012) searched for their source trees on Web of Science, other Internet search engines and published references, thus not examining the specimens first hand. The result was a major polytomy of Teleosauroidea as a whole; '*Mystriosaurus*' and *Pl*. *multiscrobiculatus* were unresolved at the base of teleosauroids, and were most closely related to all remaining taxa. Wilberg (2015a) devised an updated crocodylomorph matrix (referred to as the W matrix) which included nine teleosauroid taxa ('*S*. *brevior*'; '*Steneosaurus brevidens*' Phillips, 1871; *Teleosaurus*; *Mac. hugii*; '*S*.' *leedsi*; '*S*. *durobrivensis*'; *Pl*. *multiscrobiculatus*; '*S*.' *bollensis*; and *Peipehsuchus* [again considered to be a teleosauroid]). The original strict consensus topology produced 566 MPTs and 1649 steps (CI: 0.312; RI: 0.703) and a monophyletic teleosauroid clade (which continued to be stable regardless of different constraints placed on thalattosuchians as a whole) (Fig. 1B).

Recently, new re-descriptions of several teleosauroid taxa have allowed for the creation and updating of characters, which are now included in crocodylomorph phylogenetics. In addition, a continuously updated dataset (part of the ongoing Crocodylomorph SuperMatrix Project) is being used to

assess these characters, as well as incorporating additional taxa, and is currently focusing on Thalattosuchia evolutionary relationships. In 2016, Hastings and Young combined their crocodylomorph matrices to create the Hastings+Young dataset (which will be subsequently referred to as the H+Y matrix or dataset), which acted as the founding dataset for the SuperMatrix Project. Ristevski et al. (2018) ran the first comprehensive version of this dataset, which included fourteen thalattosuchians and three teleosauroids (*Pl*. *multiscrobiculatus*, '*S*.' *heberti* and '*S*.' *bollensis*), although the authors were focusing on goniopholids. Ősi et al. (2018), describing a new metriorhynchoid, ran an updated version of the H+Y matrix with 140 OTUs (operational taxonomic units) for 454 characters, resulting in 84 MPTs with 1477 steps; fifteen teleosauroids were included and Teleosauroidea was recovered as a monophyletic group. '*Steneosaurus*' *gracilirostris* was found as the basal-most teleosauroid, and two distinct subgroups were recovered. When re-describing '*S*.' *megarhinus*, Foffa et al. (2019) used a new modified version of the H+Y dataset (140 OTUs for 456 characters, producing 85 MPTs with 1494 steps) and provided eighteen teleosauroid taxa. The strict consensus topology (Fig. 2A) produced was a similar look to that found in Ősi et al (2018) ('*S*.' *gracilirostris* as the basal taxon, two distinct subgroups), but with differeing positioning of some taxa, most notably *Aeolodon priscus* von Sömmerring, 1814 and '*Teleosaurus*' [*Bathysuchus*] *megarhinus*, was different. In Sachs et al. (2019a) and Johnson et al. (2019), subsequent versions of the H+Y dataset were used; the phylogenetic analyses included eighteen and nineteen teleosauroid taxa, respectively, both producing an overall similar appearance of Teleosauroidea as that of Ősi et al (2018) and Foffa et al. (2019). The H+Y dataset in Sachs et al (2019a) included 141 OTUs for 460 characters, and recovered 2592 MPTs with 1508 steps; that used in Johnson et al. (2019) included 143 OTUs (one of these was a newly added teleosauroid, *Yvridiosuchus boutilieri*) for 464 characters, producing 201 MPTs with 1526 steps (Fig. 2B). In addition, Wilberg (2015b, 2018) ran

additional analyses of the W matrix, whose results were comparable to that of the recently updated H+Y matrices.

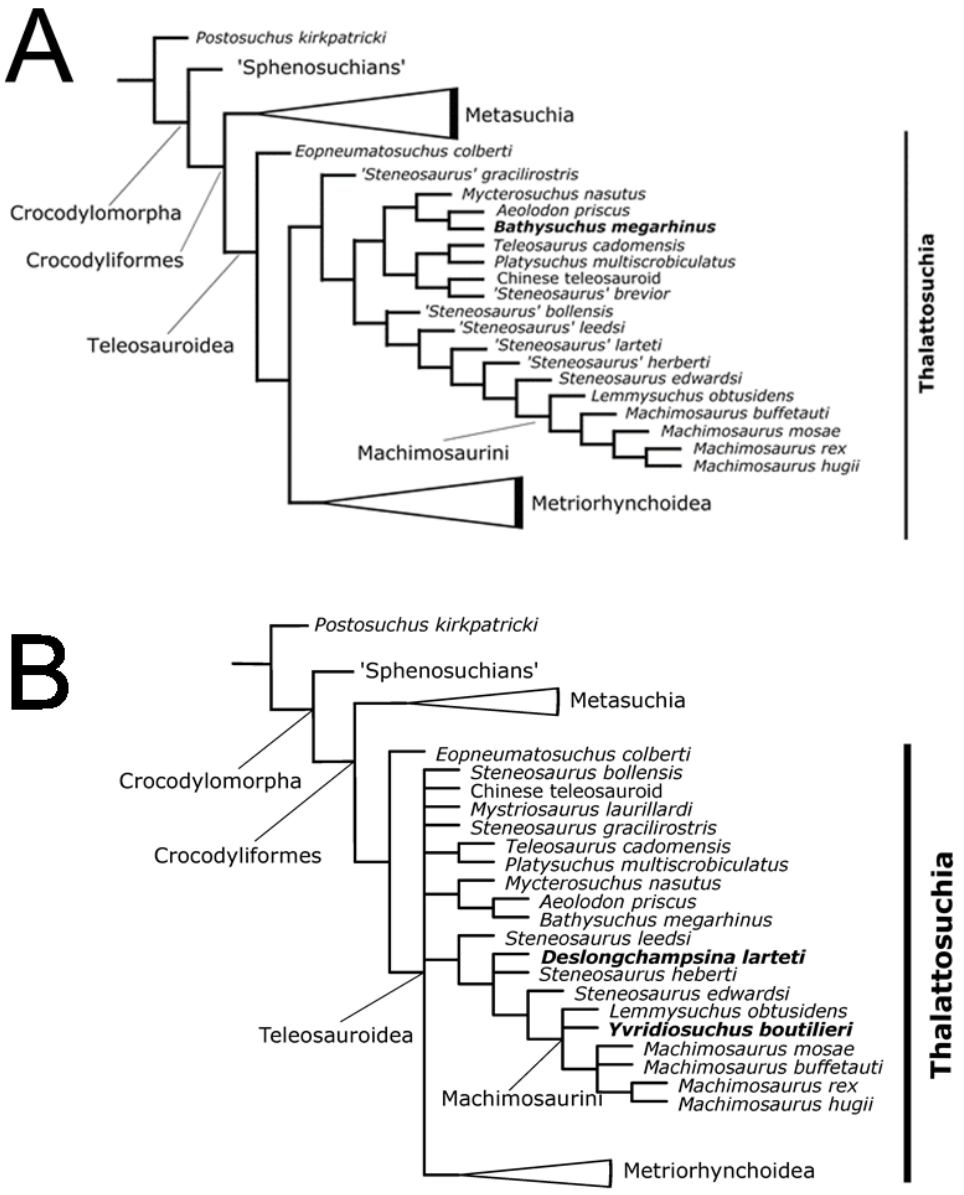


Figure 2. Results of recent teleosauroid phylogenetic analyses. Taken from (A) Foffa et al. (2019; Figure 12) and (B) Johnson et al. (2019; Figure 6A).

However, Martin et al. (2019)'s study used the W matrix provided by Wilberg (2015a), with no explanation as to why the most currently updated H+Y matrix, provided in Foffa et al. (2019), was not. The number of characters included was 375 but, more importantly, out of 78 OTUs, only 24 thalattosuchians were included, with similar taxonomic concerns found in Mueller-Töwe's (2006) analysis. For example, '*S. durobrivensis*' (junior synonym of '*S.*' *edwardsi*; see Johnson et al., 2015) was treated as a

separate taxon (with no written indication why), and many distinct species were excluded from the analysis. *Machimosaurus buffetauti* (shown to be a valid taxon in Young et al., 2014a) was treated as *Mac. hugii*, again with no clear reasoning for this change. Furthermore, three characters (174, 176, and 184) were altered from the original Wilberg (2015a) dataset, but only for the Chinese teleosauroid (IVPP V 10098). Thus, the results (12 MPTs with 1666 steps) were drastically different than those found in Young et al. (2016), Ristevski et al. (2018), Ősi et al. (2018), Foffa et al. (2019), Johnson et al. (2019) and Sachs et al. (2019a, 2019b) (Fig. 3).

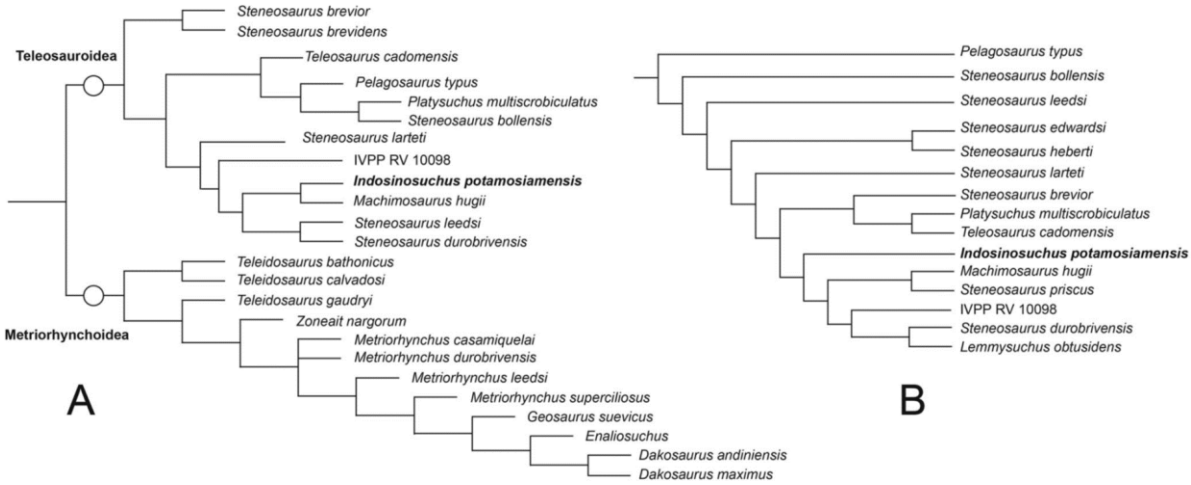


Figure 3. Phylogenetic results from Martin et al. (2019): (A) strict consensus and (B) a second consensus tree from a single obtained tree. Taken from Martin et al. (2019; Figure 15).

PHYLOGENETIC MATERIALS AND METHODS

1.1 Objectives and taxonomic sample

The aim is to create a comprehensive, higher level hypothetical phylogenetic analysis of the superfamily Teleosauroidea, and to examine and shed light on the species-level interrelationships of as many valid teleosauroid taxa as possible. As a result, the taxonomic sample focused specifically on

teleosauroids, which range from the lower Toarcian (‘*Steneosaurus*’ *gracilirostris*) to the upper Cretaceous (*Machimosaurus rex* Fanti et al., 2016). The current dataset used is a modified version of the H+Y dataset; as mentioned previously, this dataset initially combined those of Hastings and Young in 2016 and has grown substantially over the past three years, with the addition of multiple new taxa and characters. It is continuously being updated, as it forms the foundation of the ongoing Crocodylomorph SuperMatrix Project, and was first presented in Ristevski et al. (2018); however, it has been updated subsequently since then (e.g. Ősi et al. (2018), Foffa et al. (2019), Johnson et al (2019) and Sachs et al (2019a, 2019b)).

The overall taxonomic sample consisted of 153 crocodylomorph taxa (OTUs) and *Postosuchus kirkpatricki* Chatterjee, 1985, was used as the outgroup taxon. Eighty OTUs were represented by thalattosuchians, and twenty-seven of these were teleosauroids, listed as follows: ‘*Steneosaurus*’ *gracilirostris*; *Mystriosaurus laurillardi* Kaup, 1834; ‘*Steneosaurus*’ *stephani* Hulke, 1877; the Chinese teleosauroid previously referred to as *Peipehsuchus teleorhinus* (Li, 1993); *Indosinosuchus potamosiamensis* Martin et al., 2019; *Indosinosuchus* sp.; ‘*Steneosaurus*’ *baroni*; *Platysuchus multiscrobiculatus*; *Teleosaurus cadomensis*; *Mycterosuchus nasutus*; *Bathysuchus megarhinus*; ‘*Steneosaurus*’ *bollensis*; ‘*Steneosaurus*’ *leedsi*; *Sericodon jugleri* von Meyer, 1845; *Aeolodon priscus*; ‘*Steneosaurus*’ *megistorhynchus* Eudes-Deslongchamps, 1866a; *Yvridiosuchus boutilieri* (Eudes-Deslongchamps, 1868c); *Deslongchampsina larteti* (Eudes-Deslongchamps, 1866a); ‘*Steneosaurus*’ *bouchardi* Sauvage, 1872; ‘*Steneosaurus*’ *heberti*; *Steneosaurus rostromajor* Geoffroy Saint-Hilaire, 1825; ‘*Steneosaurus*’ *edwardsi*; *Lemmysuchus obtusidens*; *Machimosaurus buffetauti*; *Machimosaurus mosae*; *Machimosaurus hugii*; and *Machimosaurus rex*. Three taxa that were previously referred to as ‘*Steneosaurus*’ have recently been given new generic names: *Bathysuchus megarhinus* (Foffa et al., 2019), *Yvridiosuchus boutilieri* and *Deslongchampsina larteti* (Johnson et al., 2019). A historical name for one taxon has also currently been resurrected: *Mystriosaurus laurillardi* (Sachs et al., 2019b), which encompasses ‘*Steneosaurus brevior*’. The differences

between this dataset and that provided in the most recently published H+Y analysis (Johnson et al., 2019), are as follows:

1. Eight new taxa were added: '*S*.' *stephani*, *I. potamosiamensis*, *Indosinosuchus* sp., *Ser. jugleri*, '*S*.' *bouchardi*, '*S*.' *baroni*, '*S*.' *megistorhynchus* and *S. rostromajor*;
2. Generic names were changed for three previously included taxa (discussed below);
3. '*Steneosaurus brevior*' was changed to *Mystriosaurus laurillardi*;
4. All characters of all remaining teleosauroid taxa were re-examined and re-scored;
5. 162 character changes involving the following metriorhynchid taxa: *Cricosaurus araucanensis* (Gasparini & Dellapé, 1976) Young & Andrade, 2009; *Cricosaurus elegans* (Wagner, 1852) Wagner, 1858; *Cricosaurus lithographicus* Herrera et al., 2013b; *Cricosaurus* sp. from Cuba (see Gasparini & Iturralde-Vinent, 2001); '*Metriorhynchus*' *casamiquelai* Gasparini & Chong, 1977; *Neptunidraco ammoniticus* Cau & Fanti, 2011; *Torvoneustes mexicanus* Wieland, 1910; *Purranisaurus potens* Rusconi, 1948; and *Geosaurus gradis* Wagner, 1858 (note that these changes were made by Y. Herrera);
6. The number of characters increased from 464 to 502 (new characters 12, 13, 15, 43, 56, 58, 64, 124, 125, 167, 184, 208, 269, 270, 291, 292, 293, 294, 295, 296, 297, 339, 340, 394, 395, 396, 398, 417, 430, 431, 434, 438, 449, 456, 459, 464, 466 and 489);
7. Characters 32 and 36 were re-written;
8. Character 27 was re-written and re-defined;
9. Characters 47 and 48 were re-written and re-scored, focusing on the pholidosaurid 'beak' (ch. 47) and teleosauroid premaxilla (ch. 48); and
10. Two non-teleosauroid taxa were excluded (*Eoneustes bathonicus* (Mercier, 1933) Young et al., 2010; and Geosaurine indeterminate from Argentina) and four were included (*Carnufex carolinensis* Zanno et al., 2015; Metriorhynchoid indeterminate T;

Maledictosuchus nuyivijanan Barrientos-Lara et al., 2018; and Swiss '*Metriorhynchus hastifer*').

First-hand examination of all aforementioned teleosauroid taxa (excluding '*S.*' *bouchardi*) by MMJ resulted in the modification of the dataset.

1.2 *Character sampling and scoring*

The character sampling of the phylogenetic analysis was built by combining the character lists. The H+Y dataset initially included 387 characters (Ristevski et al., 2018), with 289 dental+craniomandibular, 95 post-cranial and 3 soft tissue. Ősi et al. (2018) contained 454 characters (334 dental+craniomandibular, 116 post-cranial and 4 soft tissue); Foffa et al. (2019) included 456 characters (336 dental+craniomandibular, 116 post-cranial, and 4 soft tissue); Sachs et al. (2019b) incorporated 460 characters (337 dental+craniomandibular, 118 post-cranial and 5 soft tissue); and Johnson et al. (2019) included 464 characters (339 dental+craniomandibular, 120 post-cranial and 5 soft tissue).

In this updated version of the H+Y dataset, 38 new characters were added (362 dental+craniomandibular, 135 post-cranial and 5 soft tissue). The complete character list comprises of 502 characters, including 286 craniomandibular (57%), 76 dental (15%), 135 post-cranial (27%) and 5 soft tissue (1%). Out of 502 characters, 26 were treated as ordered: 7, 26, 39, 47, 62, 71, 112, 181, 183, 193, 224, 242, 250, 282, 301, 359, 385, 388, 397, 409, 450, 453, 467, 468, 470, and 482. The characters were scored into a matrix using Excel 2016 and were based on first hand examination of numerous teleosauroid specimens. Additional, unavailable or missing specimens were also examined from photographs, namely from Hua (1999), Young et al. (2014a) and Schaefer et al. (2018), and mostly pertained to *Mac. hugii*, *Mac. mosae* and *Sericodon*. Photographs and information regarding '*S.*' *bouchardi* were provided by Y. Lepage. In addition, I also studied multiple '*Steneosaurus*' sp., *Machimosaurus* sp. and Teleosauroidea indeterminate specimens. Overall, I examined approximately 550 teleosauroid specimens first-hand, as well as multiple photographs, as a result of this project.

The full list of 502 characters are presented the Online Supplementary Material (OSM), available in Appendix S2.2. Newly added characters are represented by the statement **(NEW)**, ordered characters are specified by **(ORDERED)**, and characters that cannot be scored (e.g. are inapplicable) for all taxa are marked with an asterisk **(*)** following the character descriptions. Characters are preceded by additional comments and references, and are organized in the following anatomical order:

1. Skull geometry and dimensions
2. Craniomandibular ornamentation
3. Internal neuroanatomy, sensory systems and cranial exocrine glands
4. Craniomandibular pneumaticity
5. Rostral neurovascular foramina
6. Cranial rostrum
7. Skull roof
8. Orbit and temporal region
9. Palate and perichoanal structures
10. Occipital
11. Braincase, basicranium and suspensorium
12. Mandibular geometry
13. Mandible
14. Dentition and alveolar morphologies
15. Axial post-cranial skeleton
16. Appendicular skeleton: pectoral girdle and forelimbs
17. Appendicular skeleton: pelvic girdle and hind limbs
18. Dermal ossifications: osteoderms
19. Dermal ossifications: gastralia
20. Soft tissue

***1.3** Methodology*

The fully updated H+Y dataset, including 502 characters and 153 OTUs, was analysed by conducting an unweighted cladistic maximum parsimony analysis using TNT 1.5 Willi Hennig Society Edition (Goloboff et al., 2008; Goloboff and Catalano, 2016), following the methodology used in Young et

al. (2016) and in subsequent articles. Following previous iterations (Ősi et al., 2018; Foffa et al., 2019; Johnson et al., 2019; Sachs et al., 2019a, 2019b), *Postosuchus chapmani* was used as the outgroup taxon (as stated previously). Memory settings were increased with General RAM set to 900 Mb and the maximum number of trees to be held set to 99,999. Cladogram space was searched by means of the 'New Technology search' option in TNT (Sectorial Search, Ratchet, Drift, and Tree fusing) with 1000 random-addition replicates (RAS). I then subjected the trees to a Traditional Search, with 'tree bisection reconnection' (TBR) branch swapping, using 1000 replications and 10 trees saved per replication. In addition, I increased the default setting for the iterations of each method (except for Tree fusing, which was kept at three rounds). In the Sectorial Search, I ran 1000 Drift cycles (for selections of above 75) and 1000 starts and fuse trees 1000 times (for selections below 75), as well as 1000 rounds of Consensus Sectorial Searches (CSSs) and Exclusive Sectorial Searches (XSSs). For Ratchet, the program used 1000 ratchet iterations set to stop the perturbation when 1000 substitutions were made or 99% of the swapping was reached. Lastly, in Drift, the analysis included 1000 Drift cycles set to stop the perturbation when 1000 substitutions were made or 99% of the swapping was reached. The collapsing rule used was 50%, and Bremer support values of 10 were also calculated which measure branch support and indicate the number of extra steps required for a clade to collapse (Müller, 2004).

The sectorial search method (SS) is a special type of rearrangement evaluation and is the most effective when using large datasets. It selects different areas of a tree and reanalyses them separately; this way, the reduced dataset can be analysed quickly in three ways: randomly, based on a consensus or a mixture of both (Goloboff, 1999). The Ratchet method uses cycles of perturbation (by deletion and character weighting) to find the best score when TBR ('branch-breaking') is at a standstill (Nixon, 1999; Goloboff et al., 2008). It follows six specific steps: (1) generating an initial starting tree by randomly ordering the taxa; (2) the tree found at (1) serves as the starting point for the search; (3) selecting a random subset of characters, each of which is either increased in weight or jackknifed; (4) TBR of the current tree uses perturbed weights to calculate the length; (5) weights are reset and

swapping proceeds until an optimal tree is found; and (6) repeat (3) to (6) (Nixon, 1999). With this method, Ratchet is viewed as an effective way to generate new changes to a tree without altering the entirety of the tree structure (Goloboff, 1999; Nixon, 1999). In the Drift (or tree-drifting) method, suboptimal trees are found during branch-swapping, with a certain probability (Goloboff, 1999). Tree fusing (TF) exchanges subgroupings between different trees, assesses sub-tree exchanges between trees, and retains these changes; it is then able to produce the best score in which all subgroupings have an identical configuration (Goloboff, 1999). This produces trees that are closer to being optimal. With the SS, Ratchet, Drift and TF all selected, a minimum length tree (best score) was found via a driven search. A driven search will search until a best score has been found a presubscribed amount of times.

In addition to the unweighted consensus, I analysed a majority rules unweighted consensus (cut-off 50%). A majority rule is a consensus method used to summarize a specific collection of MPTs (Holder et al., 2008). Secondly, I ran the analysis once more using implied weighing (k = 12), with the 'New Technology search' options (Sectorial Search, Ratchet, Drift, and Tree fusing) with the same settings as outlined above. Implied weighting is often used to downweight supposed homoplasy (when a feature is shared in a set of species but not seen in their common ancestor) and resolve polytomies (when relationships within a phylogeny are not fully resolved) (Congreve & Lamsdell, 2016).

I also ran my dataset using MrBayes v3.2.6 (Huelsenback & Ronquist, 2001; Huelsenback et al., 2001; Ronquist et al., 2012). MrBayes is a relatively recent computer program that infers phylogenetic relationships based on different data subsets to analyse more complex and/or realistic evolutionary models (Ronquist & Huelsenback, 2003; Mishra & Thines, 2014). It is advantageous in that it allows for merging of previous information, easy interpretation of results and various computational benefits (Huelsenback & Ronquist, 2001), which permits greater flexibility when using different modes of evolution. In addition, these models are not vulnerable to long–branch attraction, a common problem in morphological datasets

involving homoplasy. Bayesian methods are generally more popular when using molecular phylogenetics but are slowly starting to become widely accepted in morphological studies, including those involving fossil data (Lewis, 2001; Prieto-Márquez, 2010; Slater, 2013; Brusatte & Carr, 2016). I used the Markov (Mk) model of Lewis (2001) in MrBayes v3.2.6, with three different variations of the Mk model applied. The first was a generalized test, using the default setting of MrBayes: this is the simplest model, in that all substitutions have the same rate or involves equal rates of character change (***rates=equal***). The second involved a gamma parameter distribution with four rate categories (***rates=gamma ngammacat=4***), which allows for differing rates of character change. The ***rates=gamma*** refers to gamma distribution rates across sites, and ***ngammacat*** sets the number of rate categories for the gamma distribution. The third involves a slightly different gamma parameter distribution (***lset applyto=(1) coding=variable rates=gamma***). This test specifies how characters are sampled, with ***variable*** indicating that only variable characters have the possibility of being sampled. In all three analyses, four chains were used and ran for 4,000,000 generations, sampled every 100 generations. Trees that were generated during the first 20,000 generations were disregarded as 'burn in'.

Abbreviations

Anatomical: **ac**, acetabulum; **?an**, possible angular; **an**, angular; **anas**, anastomosing pattern (tooth); **ant il pr**, anterior iliac process; **antorb f**, antorbital fenestra; **art**, articular; **?atl-ax**, possible atlas-axis complex; **atl**, atlas; **ax**, axis; **basiocc**, basioccipital; **?basisph**, possible basisphenoid; **basisph**, basisphenoid; **cerv r**, cervical rib; **cerv v**, cervical vertebra; **cn XII**, cranial nerve XII; **cor**, coracoid; **cor f**, coracoid foramen; *cor gr*, coronoid groove; *D3*, third dentary alveolus; **D16**, sixteenth denary alveolus; **D17**, seventeenth dentary alveolus; **den**, dentary; **dors os**, dorsal osteoderm; **dors v**, dorsal vertebra; **ectopt**, ectopterygoid; **ex n**, external nares; **f**, frontal; **f m**, foramen magnum; **fem**, femur; **fem h**, femoral head; **gl f**, glenoid fossa; **hum**, humerus; **hum h**, humeral head; **il**, ilium; **isch**, ischium; **isch bl**, ischial blade; **j**, jugal; **?l**, possible lacrimal; **l**, lacrimal (lachrymal); **k**, keel (osteoderm); **li**, limb bone (unknown); **M10**, tenth maxillary alveolus; **M12**,

twelfth maxillary alveolus; **mand f**, mandibular fenestra; **mand sy**, mandibular symphysis; **meck c**, Meckelian canal (=groove); *mx*, maxilla; **mx al**, maxillary alveolus; **n**, nasal; **occ con**, occipital condyle; **od**, odontoid; **orb**, orbit; **os**, osteoderm fragment; **P1**, first premaxillary alveolus; **P2**, second premaxillary alveolus; **P3**, third premaxillary alveolus; **?p**, possible parietal; **p**, parietal; **?pal**, possible palatine; **pal**, palatine; **pes**, pes (foot); **pmx**, premaxilla; **porb**, postorbital; **pop**, paraoccipital process; **prez**, prezygapophysis; **prf**, prefrontal; **pt**, pterygoid; **pub b**, pubic blade; **q**, quadrate; **qj**, quadratojugal; **rad**, radius; **retroart pr**, retroarticular process; **S?1**, possible first sacral vertebra; **S1**, first sacral vertebra; **S3**, third sacral vertebra; **spl**, splenial; **sq**, squamosal; **sub f**, suborbital fenestra; **sup fen**, supratemporal fenestra; **supraac cr**, supraacetabular crest; **supraocc**, supraoccipital; **suran**, surangular; **t**, isolated tooth; **?tib**, possible tibia; **tib**, tibia; **ul**, ulna.

NEW CHARACTER DESCRIPTIONS

The 38 characters written here were formulated to describe thalattosuchian, specifically teleosauroid, anatomical variation. The majority of these characters are relevant to the interrelationships of teleosauroids, and highlight previously unexamined morphological divergence between two large subclades within the group (see below). These characters are new and are here used in a cladistic analysis for the first time, and all states (indicated by a number in brackets) are subsequently figured. Character numbering follows the numbering used in the full list of characters for the present analysis (see Appendix S2).

12. Ornamentation present (prefrontal in dorsal view): yes, with shallow to deep pits and/or grooves (0), or no (1) (Fig. 4).

This character was inspired by the variety of ornamentation patterns found in the prefrontal of different teleosauroid taxa. Ornamentation is either found to be absent (completely non-existent) (state 1) or comes in the form of shallow to deep pits, in addition to shallow to deep, elongated and thin grooves (state

0). State 1 occurs in very few teleosauroids, including the basal teleosauroid '*Steneosaurus*' *gracilirostris* (NHMUK PV OR 14792), *I. potamosiamensis* (PRC-11), *Aeolodon* (MNHN.F.CNJ 78), *Sericodon* (Schaefer et al., 2018), and *Bathysuchus* (Foffa et al., 2019). The majority of teleosauroids scored as state 0; these include the Chinese teleosauroid (IVPP V 10098), *Platysuchus* (SMNS 9930), *Teleosaurus* (MNHN AC 8746), *Mycterosuchus* (NHMUK PV R 2617), '*S.*' *bollensis* (GPIT-RE-9427; MMG BwJ 565; SMNS 51555), '*S.*' *stephani* (NHMUK PV OR 49126), '*S.*' *leedsi* (NHMUK PV R 3320), *Deslongchampsina* (OUMNH J.29851), '*S.*' *heberti* (MNHN.F 1890-13), '*S.*' *edwardsi* (PETMG R 178) and machimosaurins (*Yvridiosuchus*: OUMNH J.1401; *Lemmysuchus*: LPP.M.21; *Mac. buffetauti*: SMNS 91415). However, in most taxa with state 0, the prefrontal ornamentation is limited, with few shallow grooves and pits. This is observed in '*S.*' *bollensis*, where in many specimens the prefrontal ornamentation is so faint it appears unornamented (e.g. SMNS 51753; SMNS 51957; SMNS 81699). The prefrontal in *Yvridiosuchus* (OUMNH J.1401) displays more ornamentation (mainly grooves) throughout the entirety of the bone, but these grooves are still relatively shallow; this is similar to the condition seen in '*S.*' *stephani* (NHMUK PV OR 49126). In contrast, *Mycterosuchus* (NHMUK PV R 2617) and *Mystriosaurus* (NHMUK PV OR 14781) both display characteristically deep, elongated grooves with little to no pits, and the entirety of the prefrontal is ornamented.

Note that in some taxa (such as *Indosinosuchus* sp. PRC-239), the prefrontal ornamentation is either poorly preserved or hard to see (either in the specimen or in published figures), and therefore was scored as unknown (?). It is also important to acknowledge that lack of ornamentation has also been attributed to juvenile individuals (see Vignaud, 1995); while there is evidence for this (e.g. juvenile specimens of '*S.*' *bollensis* (SMNS 10 000 and NHMW 1848 0031 0001), this character was scored using adult specimens, as juveniles were excluded from the dataset. Young et al. (2014a) noted that adult specimens of *Mac. hugii* had reduced cranial ornamentation, in particular on the premaxillae and maxillae. While not as evident as osteoderm ornamentation, skull ornamentation plays a small role in thermoregulation (e.g. Seidel, 1979; Grigg & Seebacher, 2001) by increasing

surface area (Clarac et al., 2015). It is possible that taxa with more ornamented skulls (such as *Mystriosaurus* and *Mycterosuchus*) exhibited more of a terrestrial, basking behaviour than those with less or absent cranial ornamentation (such as *Indosinosuchus*, *Mac. hugii* and *Aeolodon*), which may have been more aquatic/pelagic.

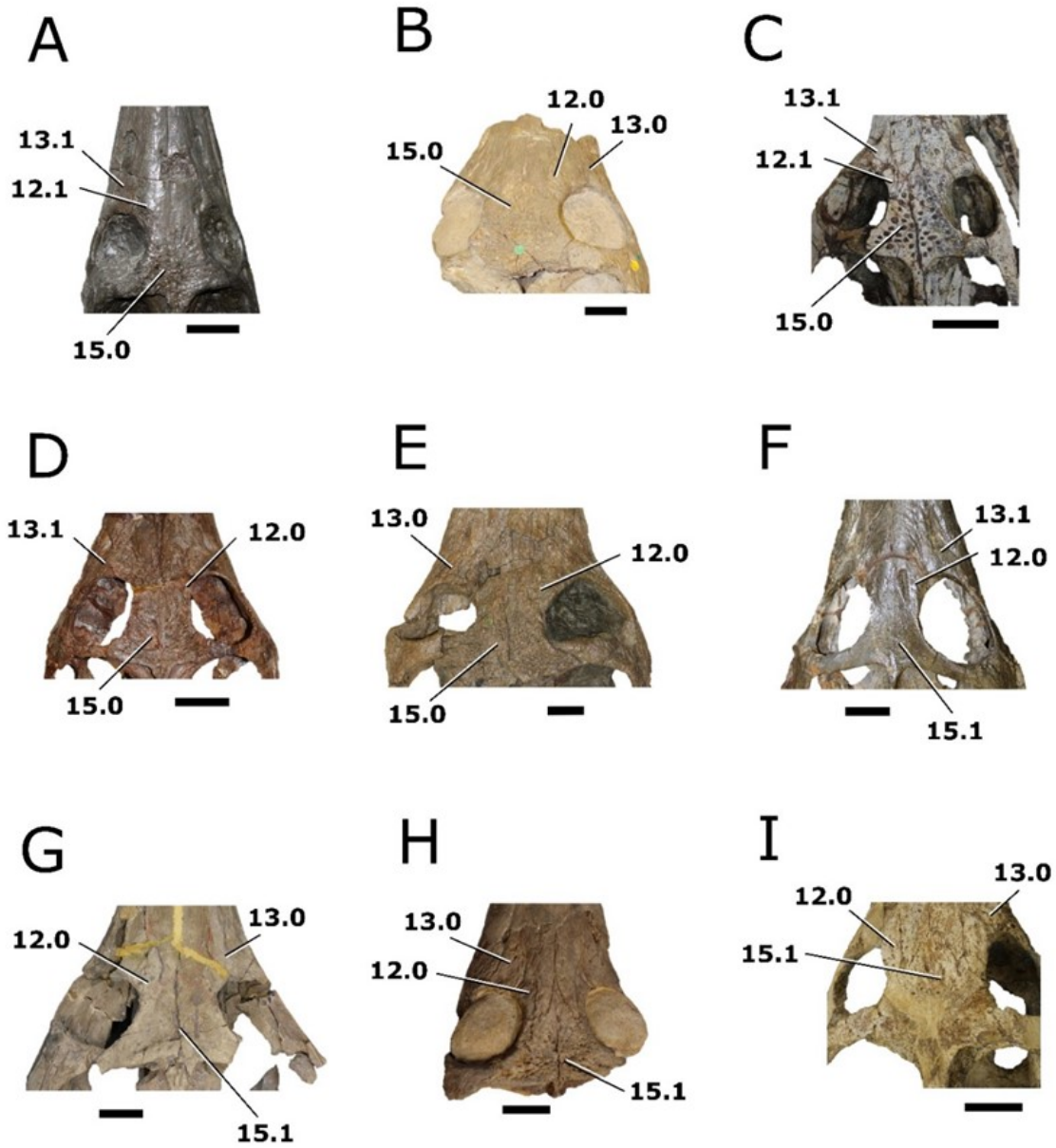


Figure 4. Comparative photographs displaying the level of ornamentation in the prefrontal (ch. 12), lacrimal (ch. 13) and frontal (ch. 15) in dorsal view. (A) '*Steneosaurus*' *gracilirostris* (NHMUK PV R 14892); (B) '*Steneosaurus*' *stephani* (NHMUK PV OR 49126); (C) *Indosinosuchus potamosiamensis* (PRC-11); (D) the Chinese teleosauroid (IVPP V 10098); (E) *Mycterosuchus nasutus* (NHMUK PV R 2617); (F) '*Steneosaurus' leedsi* (NHMUK PV R 38060; (G) '*Steneosaurus*' *edwardsi* (NHMUK PV R 2865); (H) *Yvridiosuchus boutilieri* (OUMNH J.1401); and (I) *Machimosaurus buffetauti* (SMNS 91415). Scale bars: 4 cm.

13. Ornamentation present (lacrimal in dorsal view): yes (0), with shallow to deep pits and/or grooves, or no (1) (Fig. 4).

As with the above character, the ornamentation on the lacrimal (=lachrymal) differs between taxa. Ornamentation is either absent (completely non-existent) (state 1) or comes in the form of shallow to deep pits, as well as shallow to deep, elongated and thin grooves (state 0). The majority of teleosauroids (*Mystriosaurus*: NHMUK PV OR 14781; the Chinese teleosauroid: IVPP V 10098; *Platysuchus*: SMNS 9930; *Teleosaurus*: MNHN AC 8746; *Mycterosuchus*: NHMUK PV R 2617; '*S*.' *stephani*: NHMUK PV OR 49126; *Deslongchampsina*: OUMNH J.29851; '*S*.' *heberti*: MNHN.F 1890-13; *Lemmysuchus*: NHMUK PV R 3168; *Mac. buffetauti*: SMNS 91415) exhibit state 0, with some form of ornamentation being present. Similar to the prefrontal, the lacrimals of both *Mycterosuchus* (NHMUK PV R 2617) and *Mystriosaurus* (NHMUK PV OR 14781) are extremely ornamented, and have numerous deep, elongated grooves. Generally, in teleosauroids with lacrimal ornamentation, the areas that contribute to the anterior and anterolateral orbital rims have multiple small pits and/or grooves. In *Yvridiosuchus* (OUMNH J.1401), the posterolateral area of the lacrimal (the anterolateral margin of the orbit) is particularly well ornamented with small, shallow pits, so much so that the surface of the bone appears perforated (this is best observed in lateral view). However, there are exceptions: the lacrimal of the Chinese teleosauroid (IVPP V 10098) is sparsely ornamented, with very few shallow grooves; at first glance, it appears to be unornamented. State 1 (complete lack of ornamentation) occurs in six taxa: *I. potamosiamensis* (PRC-11), *Aeolodon* (MNHN.F.CNJ 78), '*S*.' *gracilirostris* (NHMUK PV OR 14792), '*S*.' *bollensis* (SMNS 51563), '*S*.' *leedsi* (NHMUK PV R 3320) and *Sericodon* (Schaefer et al, 2018).

As discussed in ch. **12**, lack of lack of ornamentation has previously been attributed to juveniles (e.g. Vignaud, 1995); however, this character was scored using adult specimens.

15. Frontal, extension of ornamentation: extends from the centre of the frontal to lateral- and anterior-most regions (0) or restricted to centre of the frontal (1) (Fig. 4).

The frontal of teleosauroids is a single bone that is consistently ornamented throughout the majority of the group, excluding *Bathysuchus* (unnumbered LPP specimen; Fig. 5) and juveniles, such as SMNS 10 000 and NHMUK PV R 2074 (although this individual still displays weak, minimalistic ornamentation at the centre of the frontal). Ornamentation consists of pits and/or elongated grooves (usually a combination of the two), which are often deep and well-developed. The range of this ornamentation varies between taxa, either extending from the centre of the frontal to the anterior- and lateral-most areas (state 0), or is restricted to the midline or centre of the frontal (state 1), with minimal extension.

Figure 5. *Bathysuchus megarhinus* (unnumbered LPP specimen), exhibiting absent or extremely weak frontal ornamentation. Scale bar: 10 cm.

‘*Steneosaurus*’ *gracilirostris* (NHMUK PV OR 14792), ‘*S.*’ *stephani* (NHMUK PV OR 49126), ‘*S.*’ *bollensis* (MMG BwJ 565; SMNS 51563) and many basal teleosauroids (*Mystriosaurus*: NHMUK PV OR 14781; the Chinese teleosauroid: IVPP V 10098; *Indosinosuchus*: PRC-11, PRC-239; *Platysuchus*: SMNS 9930; *Teleosaurus* MNHN AC 8746; *Mycterosuchus*: NHMUK PV R 2617), have state 0; in most cases (e.g. *Mystriosaurus*:

NHMUK PV OR 14781; '*S.*' *bollensis*: MMG BwJ 565), the pits/grooves are very closely packed together, sometime merging into one another. However, in '*S.*' *gracilirostris* (MNHNL TU515) and the Chinese teleosauroid (IVPP V 10098), these irregularly shaped pits are noticeably well spaced apart from one another. In '*S.*' *stephani* (NHMUK PV OR 49126), the pits/grooves are deeper near the centre of the frontal and become shallower radiating outwards; however, they are still present at the anterior- and lateral-most areas of this bone, most noticeably the anterior area, where they contact the nasal-frontal suture. The majority of more derived teleosauroids ('*S.*' *leedsi*: NHMUK PV R 3320; '*S.*' *megistorhynchus*: Eudes-Deslongchamps, 1867-69; *Deslongchampsina*: OUMNH J.29851; '*S.*' *heberti*: MNHN.F 1890-13; '*S.*' *edwardsi*: PETMG R178; *Yvridiosuchus*: OUMNH J.1401; *Lemmysuchus*: LPP.M.21; *Mac. buffetauti*: SMNS 91415), along with *Sericodon* (SCR010-312 in Schaefer et al., 2018) and *Aeolodon* (MNHN.F.CNJ 78), share state 1. In *Yvridiosuchus* (OUMNH J.1401), the pits do extend laterally, but do not reach the lateral- or anterior-most region of the frontal; this taxon was still scored as state 1.

It has been suggested that *Bathysuchus* lacks any frontal ornamentation (Vignaud, 1995), similar to juvenile individuals. However, there may possibly be weak, nearly unnoticeable pits and grooves restricted to the midline of the frontal in this taxon (Fig. 5), in an unnumbered specimen from LPP (Foffa et al., 2019). Due to this uncertainty, this taxon was scored as (?). This is similar to the condition seen in '*Steneosaurus hulkei*' Andrews, 1913 (NHMUK PV R 2074), which is considered to be a sub-adult; however, whether or not this indicates that the LPP *Bathysuchus* (Foffa et al., 2019) is a sub-adult is beyond the scope of this manuscript, as more work into teleosauroid ontogeny needs to be done.

43. Premaxilla in dorsal view, the total anteroposterior length relative to total rostrum length is less than 25% (0) or approximately 25% or greater (1) (Fig. 6).

This character focuses on the total anteroposterior premaxillary length in relation to the total anteroposterior rostrum length of a cranium. When defining the rostral length, this refers to the length between the anterior-most premaxillae to the anterior orbital margin. This character is related to the classification of a rostrum as either longirostrine or mesorostrine. Longirostry refers to the preorbital length being 70% or more of the total basicranial length, and mesorostry states that the preorbital length is approximately 55-70% of the total basicranial length (see Young & Andrade, 2009). In the majority of teleosauroids, the premaxillary anteroposterior length is greater than 25% relative to the rostral length (state 1). This condition is observed in the basal teleosauroid '*S*.' *gracilirostris* (NHMUK PV OR 14792), as well as all taxa that are, in technical terms, longirostrine (e.g. *Indosinosuchus*: PRC-239; *Mycterosuchus*: NHMUK PV R 2617; *Aeolodon*: MNHN.F.CNJ 78; '*S*.' *bollensis*: SMNS 18672; '*S*.' *heberti*: MNHN.F 1890-13; *Lemmysuchus*: NMHUK PV R 3168). Few teleosauroids have a premaxillary anteroposteriorly length that is less than 25% of the rostral length (state 0). This is observed in *Mac. buffetauti* (SMNS 91415) and *Mac. mosae* (IRSNB cast; Hua, 1999) as well as *Mystriosaurus* (NHMUK PV OR 14781) and the Chinese teleosauroid (IVPP V 10098).

This character is particularly intriguing in regards to thalattosuchians as a clade. The basal condition is state 0; in teleosauroids, purely mesorostrine taxa (*Mystriosaurus*, the Chinese teleosauroid and *Machimosaurus*) remain at state 0, whereas the longirostrine taxa (including the basal-most teleosauroid) have shifted to state 1. This is an inverse to that seen in Metriorhynchoidea; state 0 is seen in the basal metriorhynchoids *Pelagosaurus* and *Teleidosaurus calvadosii* Eudes-Deslongchamps, 1866b, whereas state 1 is a defining character in Metriorhynchidae, in which some members significantly shorten their snouts. In metriorhynchids, the premaxillae noticeably elongate, so much so that they nearly come into contact with the nasals in more derived forms. However, in teleosauroids, both the premaxillae and maxillae are elongated, so the relative proportions of these bones to one another do not change. This way, the premaxillae never come close to contacting the nasals. Developmentally, there appears

to be a change between these two clades in the shortening of the snout, and warrants further investigation.

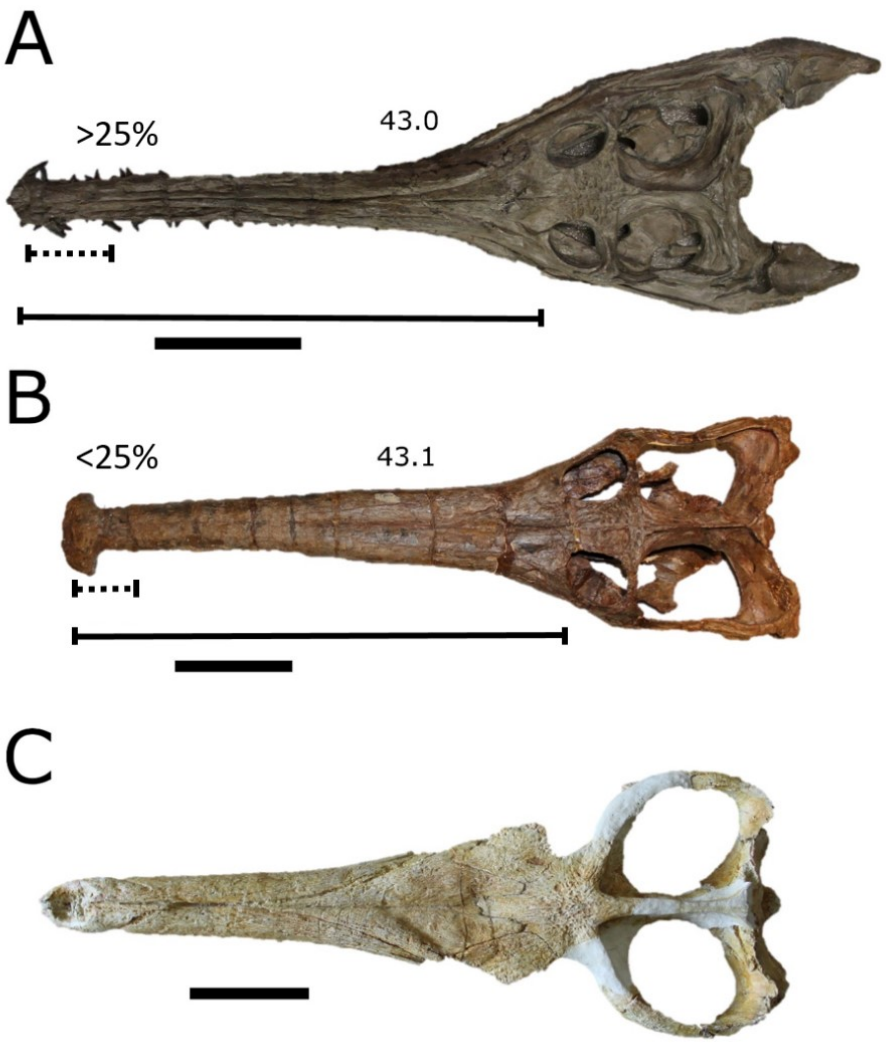


Figure 6. Comparative photographs displaying premaxillary anteroposterior length relative to rostrum length (ch. 43): (A) '*Steneosaurus*' *bollensis* (SMNS) and (B) the Chinese teleosauroid (IVPP V 10098), in addition to (C) *Metriorhynchus superciliosus* (LPP.M.48). Dashed lines (····) represent anteroposterior premaxillary length, while regular lines (—) represent total rostral length. Scale bars: 10 cm.

56. Premaxilla in dorsal view, the anterior and posterior medial margins of the external nares are formed by two bulbous projections, which is either absent (0) or present (1) (Fig. 7).

In most teleosauroids, the medial margins of the external nares are minimally convex (more so the posterior margin than the anterior margin) (state 0), causing the external nares to appear D-shaped in dorsal view. This is the condition seen in the basal '*S.*' *gracilirostris* (NHMUK PV OR 14792) in addition to *Mystriosaurus* (NHMUK PV R OR 14781), *Indosinosuchus* (PRC-11; PRC-239), the Chinese teleosauroid (IVPP V 10098), *Platysuchus* (SMNS 9930), '*S.*' *bollensis* (MMG BwJ 565), '*S.*' *leedsi* (NHMUK PV R 3806), '*S.*' *heberti* (MNHN.F 1890-13), '*S.*' *edwardsi* (NHMUK PV R 2865) and Machimosaurini (*Yvridiosuchus*: OUMNH J.1401; *Lemmysuchus*: NHMUK PV R 3168; *Mac. buffetauti*: SMNS 91415). In *Deslongchampsina* (OUMNH J.29851), the external nares margins have no convexity and instead are relatively straight and vertical. In certain taxa, however, both the anterior and posterior margins are strongly convex, making them appear 'bulging' in dorsal view. These bulbous projections extend laterally from the medial margins of the external nares, which causes them to appear distinctly '8'-shaped. This condition (state 1) is synapomorphic in *Mycterosuchus* (NHMUK PV R 2617) and *Bathysuchus* (unnumbered LPP specimen) (Foffa et al., 2019), and possibly *Aeolodon* (MNHN.F.CNJ 78) (however, specimens of this taxon are dorsoventrally crushed and slightly distorted, so it is difficult to say with certainty if it is present). It is interesting to note that the external nares of *Mystriosaurus* (NHMUK PV OR 14781) are in a way similar to state 1 in that they are more mediolaterally expanded and slightly bulging; however, the posterior margin is noticeably more bulbous (as in taxa with state 0) than the anterior margin, giving the external nares a slight 'D'-shape in dorsal view. Some specimens of '*S.*' *bollensis* (e.g. SMNS 59736) appear to have state 1, but these are dorsoventrally crushed; this distortion makes it appear as though the medial margins are bulbous whereas in reality they are not. This character was briefly introduced and discussed in Foffa et al. (2019), but was not included in the supplementary phylogenetic appendix.

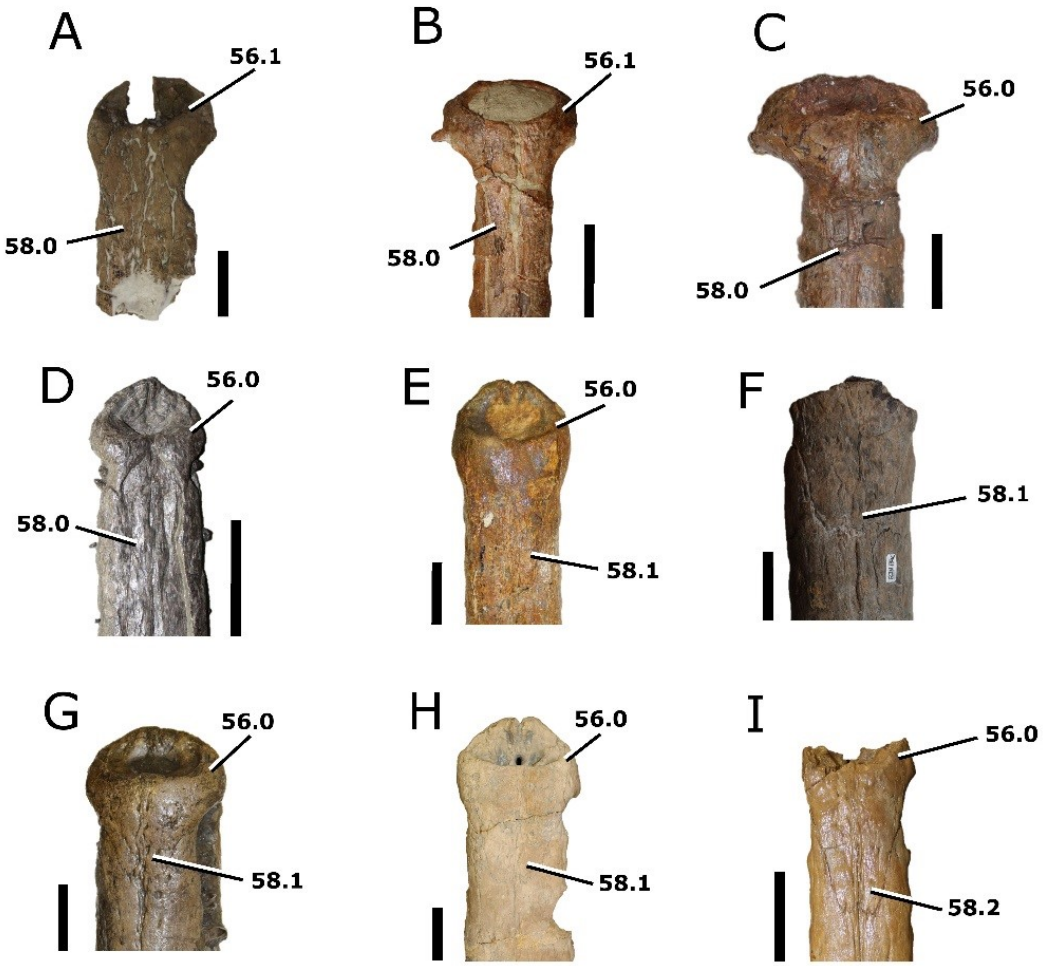


Figure 7. Comparative photographs displaying medial margins of the external nares (ch. 56) and the premaxilla-maxilla suture (ch. 58): (A) *Mycterosuchus nasutus* (CAMSM J.1420), (B) *Bathysuchus megarhinus* (unnumbered LPP specimen), (C) the Chinese teleosauroid (IVPP V 10098), (D) '*Steneosaurus*' *bollensis* (MMG BwJ 565), (E) *Deslongchampsina larteti* (OUMNH J.29851), (F) *Steneosaurus rostromajor* (MNHN.RJN 134c-d), (G) *Mystriosaurus laurillardi* (NHMUK PV OR 14781), (H) '*Steneosaurus*' *edwardsi* (NHMUK PV R 2685) and (I) '*Steneosaurus*' *leedsi* (NHMUK PV R 3320). Scale bars: 3 cm.

58. Premaxilla in dorsal view, the shape of the anteroposterior premaxilla-maxilla contact is triangular (0), subcircular (1) or 'ragged' (2) (Fig. 7).

Surprisingly, the premaxilla-maxilla contact differs between teleosauroid genera, with no clear distinction as to why. In the basal-most form ('*S.*' *gracilirostris*: NHMUK PV OR 14792), as well as the Chinese teleosauroid (IVPP V 10098); *Indosinosuchus* (PRC-11; PRC-239); *Platysuchus* (SMNS 9930); *Aeolodon* (MNHN.F.CNJ 78), *Mycterosuchus* (NHMUK PV R 2617),

Bathysuchus (unnumbered LPP specimen) and '*S.*' *bollensis* (SMNS 51753; SMNS 51984), the contact is triangular with slight or no interdigitating areas. This is referred to as state 0. An intermediate condition (state 1) shows the contact to be anteroposteriorly short and subcircular in shape (more medially horizontal than state 0), with a weak to moderate degree of interdigitating regions, generally close to the midline of the rostrum. This occurs in the type specimen of '*Steneosaurus*' (*S. rostromajor*: MNHN.RJN 134c-d) as well as *Mystriosaurus* (NHMUK PV OR 14781), '*S.*' *baroni* (NHMUK PV R 1999), '*S.*' *heberti* (MNHN.F 1890-13), '*S.*' *edwardsi* (NHMUK PV R 2865) and members of Machimosaurini (*Yvridiosuchus*: OUMNH J.1401; *Lemmysuchus*: NHMUK PV R 3168, LPP.M.21; *Machimosaurus*: SMNS 91415). A third condition (state 2) is apomorphic to '*S.*' *leedsi* (NHMUK PV R 3320, NHMUK PV R 3806): the premaxilla-maxilla suture is anteroposteriorly elongated, sub-rectangular and highly interdigitating, giving it a 'ragged'-like appearance.

As touched upon when describing cranial ornamentation, in juveniles the premaxilla-maxilla suture is expected to not be as strongly integrated as in adults (e.g. NHMW 1848-0031-0001), although the posterior-most area of the suture is jagged within young *Gavialis* specimens (Gold, 2011). However, as mentioned previously, no juveniles were scored for this dataset, as I focused specifically on coding adult individuals only.

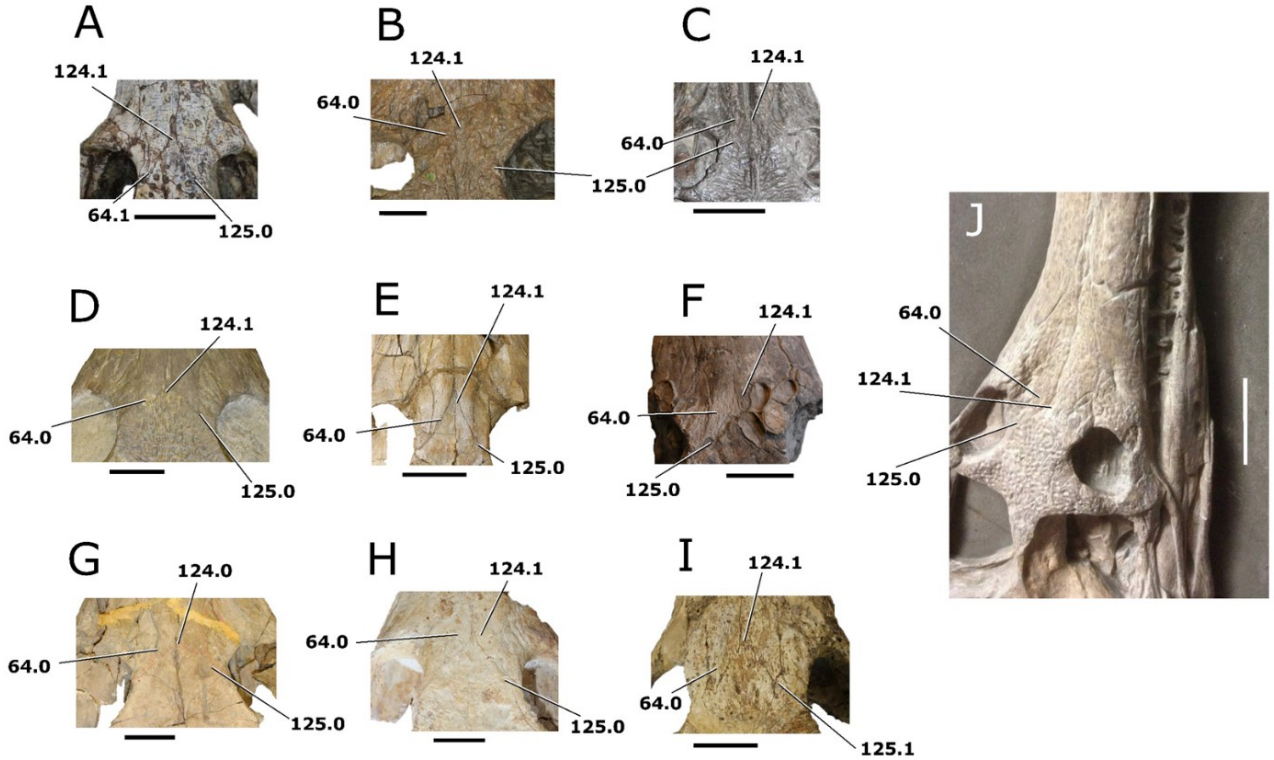


Figure 8. Comparative photographs displaying the presence/absence of elongated posterior nasal processes (ch. 64), anteromedial frontal process (ch. 124) and additional anterolateral frontal projections (ch.125): (A) *Indosinosuchus potamosiamensis* (PRC-11), (B *Mycterosuchus nasutus* (NHMUK PV R 2617), (C) '*Steneosaurus*' *bollensis* (NHMW-1878-0047-0001), (D) '*Steneosaurus*' *stephani* (NHMUK PV OR 49126), (E) '*Steneosaurus*' *leedsi* (NHMUK PV R 3320), '*Steneosaurus*' *edwardsi* ((F): MNHN.RJN 118; (G) NHMUK PV R 2865), (H) *Lemmysuchus obtusidens* (LPP.M.21), (I) *Machimosaurus buffetauti* (SMNS91415) and (J) *Platysuchus multiscrobiculatus* (SMNS 9930). *Platysuchus* photograph provided by MTY. Scale bars: 4 cm.

64. Nasals, extremely anteroposteriorly elongated posterior processes that do not contact (0) or make contact with (1) the anterior rim of orbit (Fig. 8).

In the majority of teleosauroids (e.g. the Chinese teleosauroid: IVPP V 10098; *Platysuchus*: SMNS 9930; *Mycterosuchus*: NHMUK PV R 2617; '*S.*' *megistorhynchus*: Eudes-Deslongchamps, 1867-69; *Deslongchampsina*: OUMNH J.29851; '*S.*' *edwardsi*: NHMUK PV R 3701; *Lemmysuchus*: LPP.M.21), including the basal-most teleosauroid ('*S.*' *gracilirostris*: NHMUK PV OR 14792), the posterior processes of the nasals reach or extend slightly past the anterior rim of the orbits (state 0). In addition, these processes are positioned medially, slightly mediolaterally thin in the posterior-most area,

and do not come into close contact with the medial orbital margin. They are shorter and broader in '*S*.' *stephani* (NHMUK PV OR 49126) than any other teleosauroid, and are relatively short (but not as broad) in *Mystriosaurus* (NHMUK PV OR 14781). In *Yvridiosuchus* (OUMNH J.1401), these processes do reach past the anterior orbital rim but not substantially, are medially broad and do not contact the medial rim of the orbit; this taxon was therefore scored as state 0. However, *I. potamosiamensis* (PRC-11) clearly possesses state 1, in which the nasals have extraordinarily anteroposteriorly elongated posterior processes; these are mediolaterally thin and come into contact with the medial rim of the orbit.

This feature was briefly touched upon in Martin et al. (2019); it was referred to as present in all *Indosinosuchus* taxa, because of it being noticeable in PRC-11 (the designated holotype of *I. potamosiamensis*). However, PRC-239, which is noted as *Indosinosuchus* sp. herein, is poorly preserved in that area, and therefore I have scored it as unknown (?) in this dataset.

124. Frontal, anteromedial process shape and length relative to nasals: anterior projection of frontal is mediolaterally broad and does not extend far anteriorly past anterior orbital rim into nasals (0) or anterior projection of frontal is mediolaterally thin and extends anteriorly past anterior orbital rim into nasals (1) (Fig. 8).

This character focuses on the relative shape, width and length of the frontal anteromedial process in relation to the nasals. In the majority of teleosauroids, this process is triangular, thin and anteromedially elongated, usually extending past the anterior orbital margin (state 1). This is seen in taxa such as the basal-most form '*S*.' *gracilirostris* (NHMUK PV OR 14792) as well as *Mystriosaurus* (NHMUK PV OR 14781), the Chinese teleosauroid (IVPP V 10098), *Indosinosuchus* taxa (PRC 11; PRC 239), *Platysuchus* (SMNS 9930), *Mycterosuchus* (NHMUK PV R 2617), *Aeolodon* (MNHN.F.CNJ 78), '*S*.' *bollensis* (MMG BwJ 565; SMNS 51555), '*S*.' *leedsi* (NHMUK PV R 3320), *Deslongchampsina* (OUMNH J.29851), '*S*.' *heberti*

(MNHN.F 1890-13), '*S.*' *edwardsi* (MNHN.RJN 118; PETMG R178) and Machimosaurini (*Yvridiosuchus* OUMNH J.1401; *Lemmysuchus* LPP.M.21; *Mac. buffetauti* SMNS 91415). It is interesting to note that the anteromedial frontal processes seen in *Yvridiosuchus*, *Indosinosuchus*, '*S.*' *leedsi* and *Mac. buffetauti* are considerably more elongated and mediolaterally thin than in the other aforementioned taxa.

The processes seen in *Teleosaurus* (MNHN AC 8746) and *Sericodon* (SCR010-312 in Schaefer et al., 2018) appear to be state 1, but it is unclear; therefore, both of these taxa were scored as {01}. Only one taxon, '*S.*' *stephani* (NHMUK PV OR 49126), definitely expresses state 0, in which the anteromedial frontal process is noticeably mediolaterally broadened (giving it a subcircular appearance in dorsal view) and anteroposteriorly short; therefore, this character state is currently apomorphic to '*S.*' *stephani*.

125. Frontal in dorsal view, small anterolateral projections between nasals and prefrontals are absent (0) or present (1) (Fig. 8).

The frontal projections are two small triangular-shaped intrusions of bone that are anterolaterally oriented, situated between the prefrontals and nasals, and only observed in dorsal view. Most teleosauroids do not have these extra projections; instead, the frontal suture is flush with that of the posterior nasal processes (state 0). This condition is clearly seen in the basal teleosauroid '*S.*' *gracilirostris* (NHMUK PV OR 14792) and the Chinese teleosauroid (IVPP V 10098), *Indosinosuchus* (PRC-11, PRC-239), *Platysuchus* (SMNS 9930), *Teleosaurus* (MNHN AC 8746), *Mycterosuchus* (NHMUK PV R 2617), *Aeolodon* (MNHN.F.CNJ 78), '*S.*' *bollensis* (MMG BwJ 565), '*S.*' *stephani* (NHMUK PV OR 49126), '*S.*' *leedsi* (NHMUK PV R 3320), *Deslongchampsina* (OUMNH J.29851), '*S.*' *heberti* (MNHN.F 1890-13), '*S.*' *edwardsi* (NHMUK PV R 2865), *Yvridiosuchus* (OUMNH J.1401) and *Lemmysuchus* (LPP.M.21). The presence of these frontal projections is an apomorphic state, however, in the taxon *Mac. buffetauti* (Martin & Vincent, 2013; SMNS 91415), in which they are large, mediolaterally broadened and clearly noticeable (state 1). '*S.*' *stephani* (NHMUK PV OR 49126) may also

have state 1, but it is uncertain if this represents a true suture or a fracture (the latter appears to be more likely). Therefore, this taxon is currently scored as state 0.

167. Jugal anterior process is absent (0) or is slender, elongated and extends anteriorly (1) (Fig. 9).

The jugal is a large, triradiate bone, with the anterior area forming the lateral border and ventral margin of the orbits. The majority of teleosauroids have a shortened anterior process of the jugal that does not extend past the anterior orbital margin (state 0). This is clearly seen in the basal form '*S*.' *gracilirostris* (MNHNL. TU515) as well as *Mystriosaurus* (NHMUK PV OR 14781), the Chinese teleosauroid (IVPP V 10098), *Platysuchus* (SMNS 9930), *Teleosaurus* (MNHN AC 8746), *Mycterosuchus* (NHMUK PV R 2617), '*S*.' *bollensis* (PMU R161) and *Deslongchampsina* (OUMNH J.29851). In *Deslongchampsina* (OUMNH J.29851), the anterior jugal process is marginally extended past the anterior orbital margin, but barely and it is still shortened and rounded; therefore, it is scored as state 0.

However, an interesting state in most Oxford Clay Formation (OCF) and equivalent taxa is that the anterior jugal becomes dorsoventrally curved, narrow and anteroposteriorly elongated, and extends substantially past the anterior orbital margin, at times nearly to the posterior region of the antorbital fenestra. Johnson et al. (2017) first highlighted and figured this character, best seen in lateral view, in *Lemmysuchus* (PETMG R39). This condition (state 1) is also present in the taxa '*S*.' *leedsi* (NHMUK PV R 3320), '*S*.' *edwardsi* (MNHN.RJN 118; PETMG R178), '*S*.' *heberti* (MNHN.F 1890-130) and other members of Machimosaurini in addition to *Lemmysuchus* (*Yvridiosuchus*: OUMNH J.1401; *Mac. buffetauti*: SMNS 91415). This anterior process is particularly long in *Yvridiosuchus* (OUMNH J.1401) and encounters the posterior-most margin of the antorbital fenestra. However, *Mycterosuchus*, another OCF taxon, is currently scored as 0; the holotype (NHMUK PV R 2617) does not appear to have this condition, but another

specimen (CAMSM J.1420) currently thought to be attributed to this genus does, and is currently being investigated.

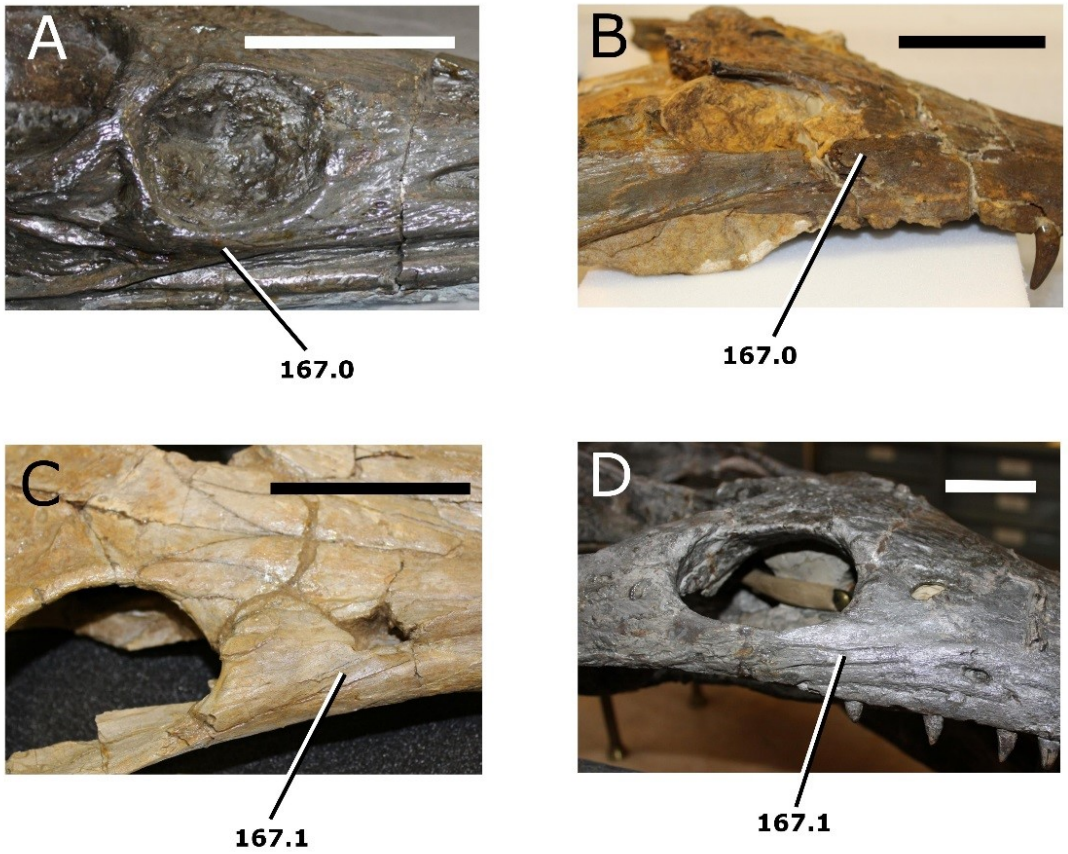


Figure 9. Close up comparative photographs displaying the anterior elongation of the jugal (ch. 167) in (A) '*Steneosaurus*' *gracilirostris* (NHMUK PV OR 14792); (B) *Deslongchampsina larteti* (OUMNH J.29851); (C) '*Steneosaurus*' *leedsi* (NHMUK PV R 3320); and (D) '*Steneosaurus*' *heberti* (MNHN.F 1890-13). Scale bars: 5 cm.

184. Maxilla in palatal view, shape of anterior maxilla is tapering (sub-triangular) (0) or straightened (sub-rectangular) (1) (Fig. 10).

This character focuses on the anterior premaxilla-maxilla contact in palatal view, which is positioned parallel to the fourth premaxillary alveoli. State 1 is a synapomorphic character for members of Teleosauroidea; the contact is horizontal and straight, and sub-rectangular in shape. This character is one new key difference from Metriorhynchoidea, in which the contact is sub-

triangular and anteriorly directed (state 0) (e.g. *Metriorhynchus superciliosum*: LPP.M.48).

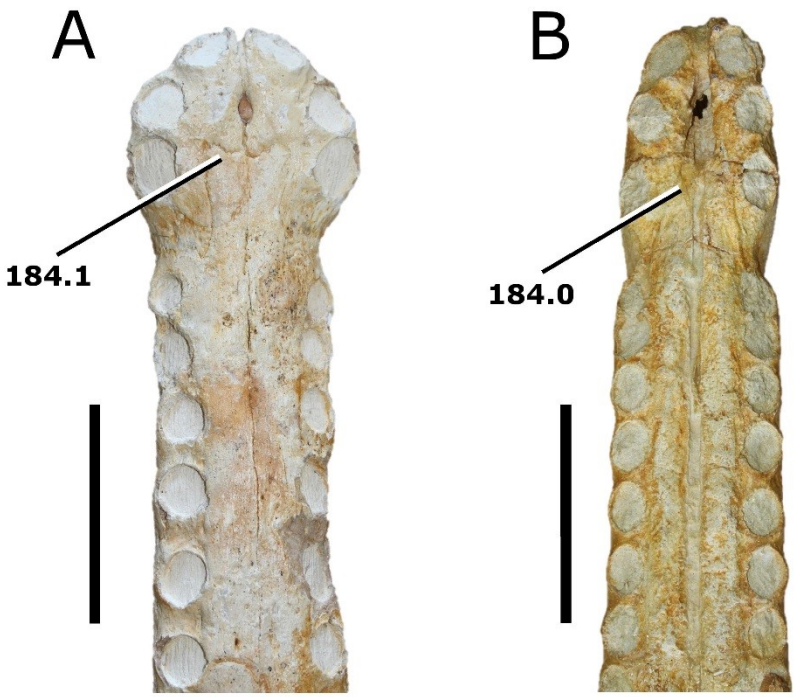


Figure 10. Comparative photographs displaying the premaxillary-maxillary suture in palatal view (ch. 184): (A) Teleosauroidea (*Lemmysuchus obtusidens* LPP.M.21) and (B) Metriorhynchoidea (*Metriorhynchus supercilious* LPP.M.48). Scale bars: 7 cm.

208. Paraoccipital process and exoccipital-opisthotic are approximately the same size (0) or paraoccipital process is substantially larger than exoccipital-opisthotic (1) (Fig. 11).

The paraoccipital processes are the posterior-most part of the exoccipital-opisthotics, which makes up most of the occiput, contacts the supraoccipital dorsally and forms the dorsal and lateral margins of the foramen magnum (Brusatte et al., 2016; Johnson et al., 2018). The paraoccipital processes are pronounced, horizontally directed and have a circular or straightened (see '*S.*' *gracilirostris*: MNHNL TU515) distal margin. The paraoccipital processes are approximately the same size as the rest of the exoccipital-opisthotic (state 0). This is seen in the basal form '*S.*' *gracilirostris* (MNHNL TU515) as well as most teleosauroids (the Chinese teleosauroid: IVPP V 10098; *Indosinosuchus*: PRC-11, PRC-239; *Platysuchus*: SMNS 9930; *Teleosaurus*:

MNHN AC 8746; *Mycterosuchus*: NHMUK PV R 2617; *Bathysuchus*: unnumbered LPP specimen; *Sericodon*: SCR010-312 in Schaefer et al., 2018; '*S*.' *bollensis*: SMNS 81699; '*S*.' *stephani*: NHMUK PV OR 49126; '*S*.' *leedsi*: NHMUK PV R 3320; *Deslongchampsina*: OUMNH J.29851; '*S*.' *heberti*: MNHN.F 1890-13; '*S*.' *edwardsi*: PETMG R178; *Yvridiosuchus*: OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3168; *Mac. buffetauti*: SMNS 91415; *Mac. mosae*: Young et al., 2014a). The paraoccipital processes may be marginally smaller than the exoccipital-opisthotics in few teleosauroids ('*S*'.' *gracilirostris*: MNHNL TU515; *Mac. buffetauti*: SMNS 91415). In *Mac. hugii* (MG-8730-2), the paraoccipital processes are noticeably and substantially larger than the exoccipital-opisthotics; this condition (state 1) is apomorphic for this taxon. Due to these large, expanded paraoccipital processes, the cervicocranial depressor muscles (which attach to the processes) would have been well-developed, possibly assisting *Mac. hugii* with diving (Krebs, 1968; Young et al., 2014a).

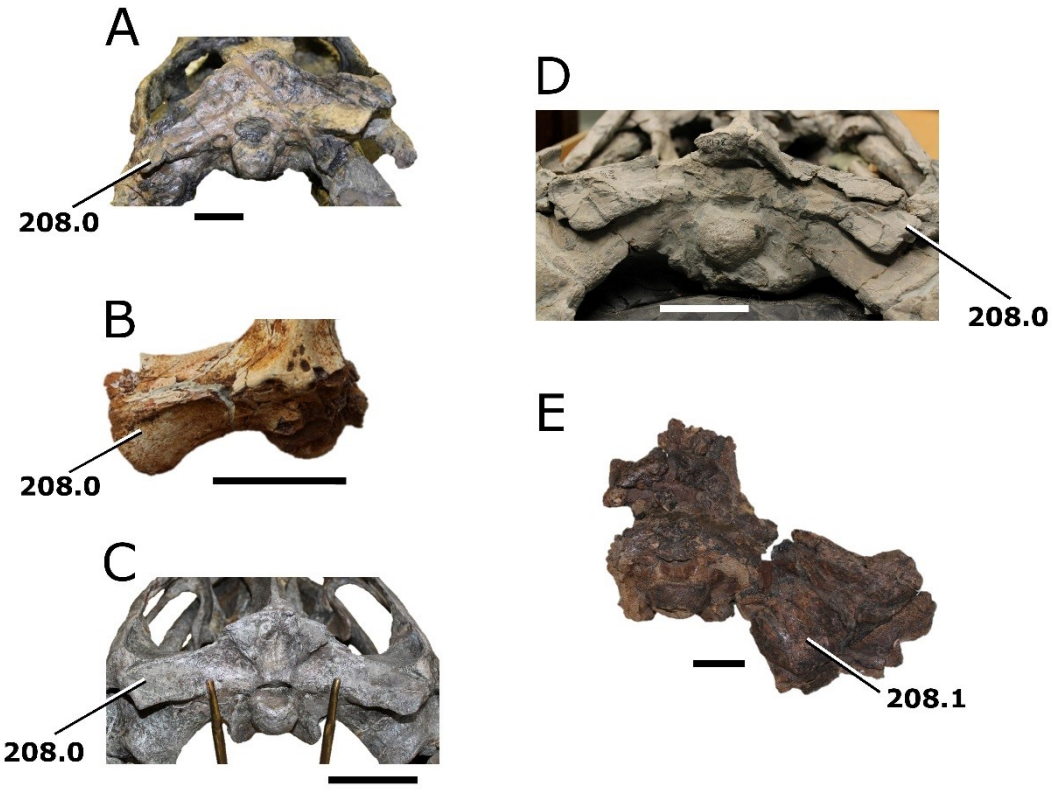


Figure 11. Comparative photographs displaying the exoccipital and paraoccipital processes (ch. 208): (A) '*Steneosaurus*' *gracilirostris* (MNHNL TU515), (B '*Steneosaurus*' sp. (IRSNB R 0140), (C) '*Steneosaurus*' *heberti* (MNHN.F 1890-13), (D) '*Steneosaurus*' *edwardsi* (PETMG R178) and (E) *Machimosaurus hugii* (MG 8730). Scale bars: 5 cm.

269. Splenials in dorsal view, the excavation of Meckelian groove on the dorsal surface of symphyseal splenials is deep (0) or shallow (1) (Fig. 12).

This character focuses on the excavation of the Meckelian groove (=canal) seen on the dorsal surface of the symphyseal splenials. The Meckelian groove is the area of the lower jaw where the posterior two halves articulate, and exposes the Meckelian cartilage (which is an attachment surface for muscles that assist in closing the jaw) (Holliday & Nesbitt, 2013). This is a key feature that helps in separating one particular subgroup of teleosauroids (including '*S*.' *heberti*, '*S*.' *edwardsi* and Machimosaurini) from the rest of Teleosauroidea. In more basal and longirostrine teleosauroids (e.g. *Teleosaurus*: Eudes-Deslongchamps, 1867-69; *Mycterosuchus*: NHMUK PV R 2617; '*S*.' *bollensis*: SMNS 53422; '*S*.' *megistorhynchus*: OUMNH J.1414; '*S*.' *leedsi*: NHMUK PV R 3806), the Meckelian groove is anteroposteriorly long relative to jaw length and deeply excavated (state 1). In the taxa '*S*.' *heberti* (MNHN.F 1890-13), '*S*.' *edwardsi* (NHMUK PV R 3701) and Machimosaurini (*Yvridiosuchus*: OUMNH J.1417; *Lemmysuchus*: LPP.M.21; *Machimosaurus*: SMNS 91415; NMS 7021 in Young et al., 2014a), the Meckelian groove is shallow with little to no excavation (state 0). This feature of teleosauroids was first discussed by Johnson et al. (2017), and then again in Johnson et al. (2019), but was not included in the supplementary files. Holliday & Nesbitt (2013) suggest that differences in mandibular symphysis anatomy, including those seen in the Meckelian groove, are indicative of a major shift in diet and cranial functions. This, paired with a modification towards larger supratemporal fenestrae and more robust skulls and teeth (excluding '*S*.' *heberti* dentition), indicate the changing of prey preferences in this subclade of teleosauroids, and the modifications in the skull that allow them to acquire said prey. In addition, Holliday & Nesbitt (2013) also note that fusing the opposing mandibular symphyses acts as a strengthening mechanism (against torsion and maintaining force transference between both sides of the jaw); while all teleosauroids only suture these halves together, this joint is significantly less perceptible in '*S*.' *edwardsi* (NHMUK PV R 3701)

and machimosaurins (e.g. *Yvridiosuchus*: OUMNH J.1417; *Lemmysuchus*: LPP.M.21).

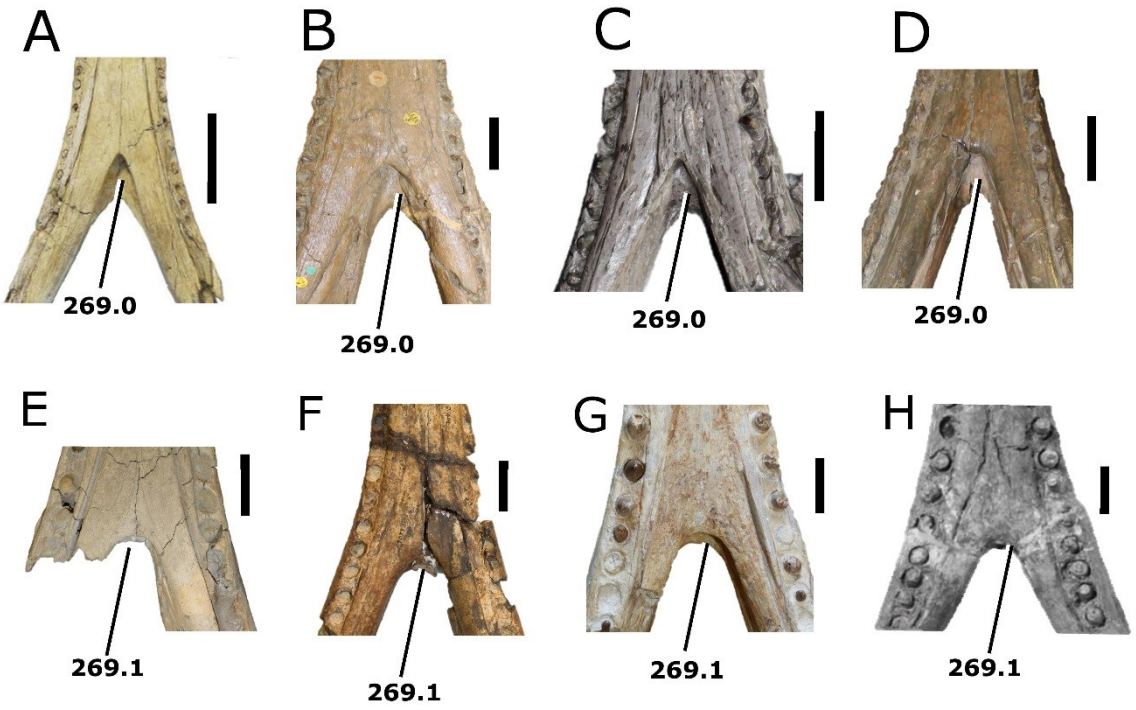


Figure 12. Comparative photographs displaying the Meckelian groove (canal) (ch. 269) in (A) *Sericodon jugleri* (SCR010-1184; Schaefer et al., 2018), (B) *Mycterosuchus nasutus* (NHMUK PV R 2617), (C) '*Steneosaurus*' *bollensis* (53422), (D) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806), (E) '*Steneosaurus hulkei*' (='*Steneosaurus*' *edwardsi*) (NHMUK PV R 2074), (F) *Yvridiosuchus boutilieri* (OUMNH J.1404), (G) *Lemmysuchus obtusidens* (LPP.M.21), and (H) *Machimosaurus mosae* (Young et al., 2014a). Scale bars: 3 cm.

270. Angular dorsal curvature is gradual (0) or sharp and abrupt (1) (Fig. 13).

In most teleosauroids, the angular is an elongated, robust bone of the posterior mandible that occupies significantly more area than the articulating surangular. It is dorsoventrally deep, especially in '*S*.' *heberti* (MNHN.F 18901-13) and machimosaurins (*Yvridiosuchus*: OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3168; *Machimosaurus*: IRSNB cast), forms the posteroventral and ventral borders of the mandibular fenestra, and contacts the articular posteriorly and dentary anteriorly. Specifically, the posterior angular contacts the retroarticular process of the articular. In the majority of teleosauroids, the ventral margin of the angular gradually curves posterodorsally (state 0). This condition is seen in *Indosinosuchus* (PRC-11;

PRC-239), *Platysuchus* (SMNS 9930), *Sericodon* (SCR010-1184 in Schaefer et al., 2018), *Aeolodon* (MNHN.F.CNJ 78), '*S.*' *bollensis* (SMNS 51753), '*S.*' *leedsi* (NHMUK PV R 3806) and '*S.*' *megistorhynchus* (OUMNH J.1414). Both '*S.*' *gracilirostris* (MNHNL TU515; NHMUK PV OR 15500) and *Mystriosaurus* (NHMUK PV OR 14781) also display state 0; however, the anterior-most angular is straight (horizontally directed), and the dorsoposterior curvature is poor and limited to the posterior area. The curvature of the angular differs in '*S.*' *heberti* (MNHN.F 1890-13), '*S.*' *edwardsi* (PETMG R178) and Machimosaurini (*Yvridiosuchus*: OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3168; *Machimosaurus*: IRSNB cast, SMNS 91415), in which the dorsoposterior curvature is immediate, sharp and abrupt (state 1). This curve mainly influences the *m. pterygoideus ventralis* on the lateral and ventral sides, as well as the *m. depressor mandibulae* on the dorsal side, which aid in closing the jaw (Holliday, 2006; Holiday et al., 2013). This character is best observed in lateral view.

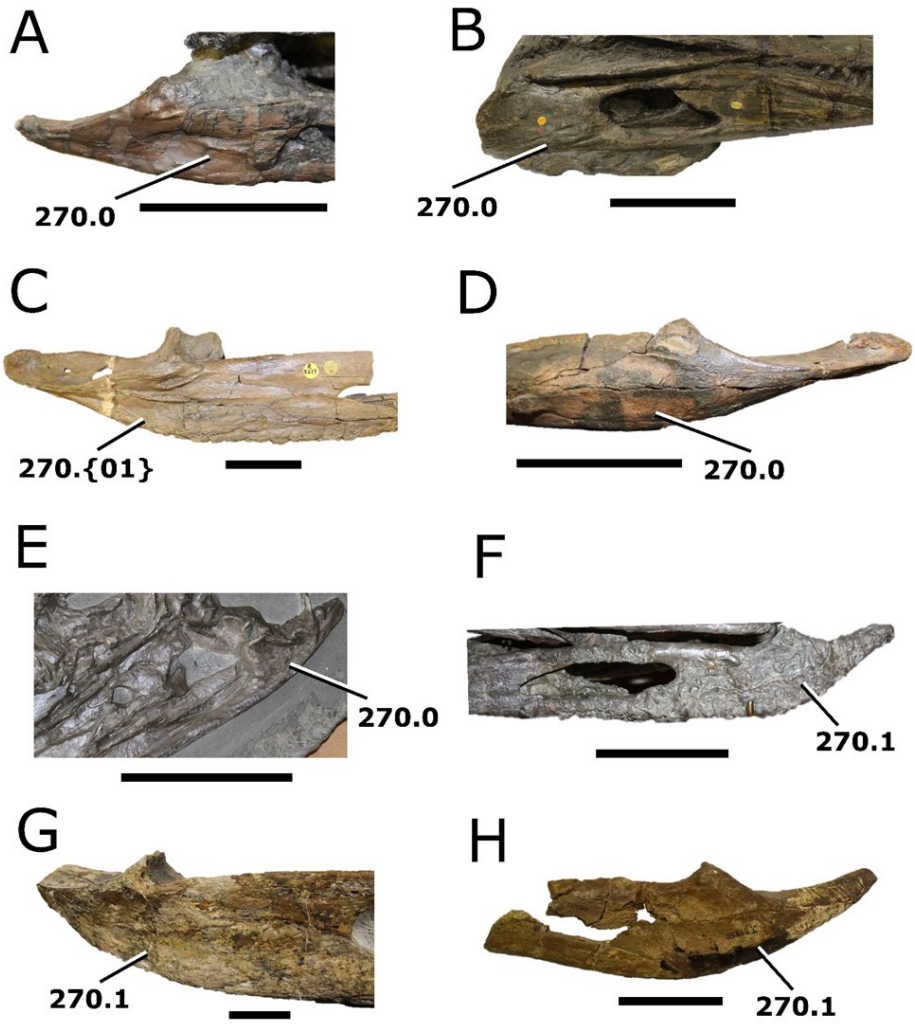


Figure 13. Comparative photographs displaying the curvature of the retroarticular process (ch. 270) (in lateral view). (A) '*Steneosaurus*' *gracilirostris* (MNHNL TU515), (B) *Mystriosaurus laurillardi* (NHMUK PV OR 14781), (C) *Mycterosuchus nasutus* (NHMUK PV R 2617), (D) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806), (E) '*Steneosaurus*' *bollensis* (SMNS 58876), (F) '*Steneosaurus*' *heberti* (MNHN.F 1890-13), (G) *Machimosaurus buffetauti* (SMNS 91415) and (H) *Yvridiosuchus boutilieri* (OUMNH J.29850). Scale bars: 15 cm (B, E-F) and 5 cm (A, C-D, G-H).

The differences in this character was first highlighted and figured by Johnson et al. (2017), and subsequently in Johnson et al. (2018), Martin et al. (2019), Johnson et al. (2019) and Sachs et al. (2019b), but was not included in any accompanying supplementary files.

291. Maxilla, reception pits are either absent, shallow throughout, or conspicuous only in the anterior maxilla (0) or pronounced and deep throughout the entirety of the maxilla (1) (Fig. 14).

The maxillae are two paired, elongate bones that represent a substantial part of the rostrum in crocodylomorphs, especially in longirostrine forms. Along the lateral surface of the maxillae, reception pits for the opposing tooth row (dentary) are visible, parallel and slightly dorsally positioned to the tooth row. State 0 includes taxa that have either shallow or absent reception pits; however, it is important to note that reception pits are present in all teleosauroids, so for the purposes of this analysis, state 0 of character **291** focuses purely on taxa with shallow reception pits. These may vary substantially in terms of noticeability; for example, they are present but near-invisible in the basal taxon '*S.*' *gracilirostris* (MNHNL TU515) and are relatively shallow in most taxa (*Mystriosaurus*: NHMUK PV OR 14781; *Indosinosuchus*: PRC 11, PRC-239; the Chinese teleosauroid: IVPP V 10098; *Platysuchus*: SMNS 9930; *Teleosaurus*: MNHN AC 8746, Eudes-Deslongchamps, 1867-69; *Mycterosuchus*: NHMUK PV R 2617; *Bathysuchus*: unnumbered LPP specimen; *Sericodon*: BSY008-622 in Schaefer et al., 2018; *Aeolodon*: MNHN.F.CNJ 78; '*S.*' *bollensis*: SMNS 51753, SMNS 51957). In these taxa, the reception pits are noticeable but small and shallow throughout the anterior and mid-maxilla, and gradually

disappear posteriorly. *Mystriosaurus* (NHMUK PV OR 14781) is interesting in the fact that the reception pits are relatively deep at the mid-maxilla (however, this may be due to preservation), and *Indosinosuchus* sp. (PRC 239) has small, shallow reception pits throughout the entirety of the maxilla. In addition, state 0 includes taxa that have noticeable reception pits in the anterior region of the maxilla that gradually disappear towards the mid-to posterior regions. This condition is seen in the genera *Deslongchampsina* (OUMNH J.29851) and '*S.*' *leedsi* (NHMUK PV R 3806); the reception pits are well-developed and deep in the anterior maxilla, but they quickly disappear by the middle of the maxilla.

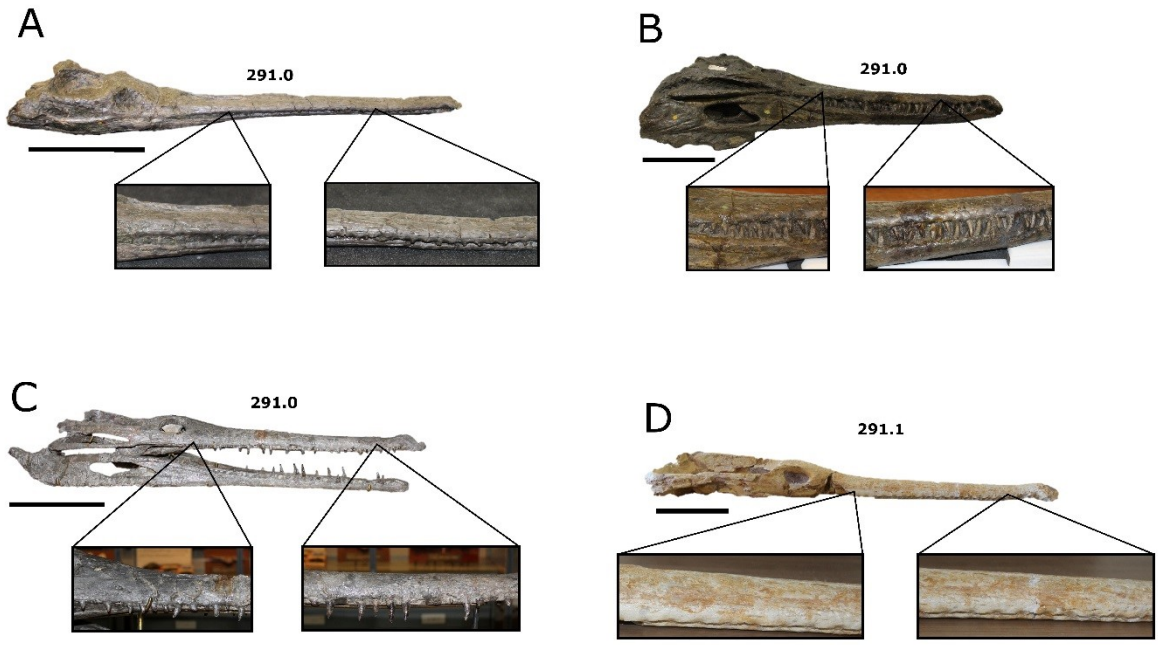


Figure 14. Comparative photographs displaying the reception pits (in right lateral view) (ch. 291). (A) '*Steneosaurus*' *gracilirostris* (NHMUK PV OR 15500), (B) *Mystriosaurus laurillardi* (NHMUK PV OR 14781), (C) '*Steneosaurus*' *heberti* (MNHN.F 1890-13) and (D) *Lemmysuchus obtusidens* (LPP.M.21). Scale bars: 17 cm.

In some taxa, however, the reception pits are deep and noticeable throughout the near-entirety or entirety of the maxilla, most notably so in the anterior and middle regions, although they do become smaller when progressing posteriorly. This condition is seen in machimosaurins (*Yvridiosuchus*: OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3618; *Mac. buffetauti*: SMNS 91415) as well as '*S.*' *baroni* (NHMUK PV R 1999), *S. rostromajor* (MNHN.RJN 134c-d, to some extent) and large individuals of '*S.*'

edwardsi (PETMG R178). In machimosaurins (*Yvridiosuchus*: OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3618; *Mac. buffetauti*: SMNS 91415), the reception pits are small but deep until the posterior-most maxilla, whereas in '*S.*' *baroni* (NHMUK PV R 1999), *S. rostromajor* (MNHN.RJN 134c-d) and '*S.*' *edwardsi* (PETMG R178) they become small and shallow but still present after the mid-maxilla. Young et al. (2014a) first highlighted the presence of deep maxillary reception pits in the genus *Machimosaurus*. Subsequent studies (Johnson et al., 2017; Johnson et al., 2019; Sachs et al., 2019b) noted the characteristics of these reception pits, but did not include them in the accompanying supplementary files.

292. Premaxilla, P1-P2 either does not form a couplet and the interalveolar spacing between P1-P2 and P3-P4 relatively the same size (0) or forms a couplet with the interalveolar spacing between P1-P2 and P3-P4, with P1-P2 being separated by a thin lamina and P3-P4 being well separated (1) (Fig. 15).

In palatal view, there are four premaxillary alveoli found in the majority of teleosauroids. This excludes members of *Machimosaurus* (Young et al., 2014a), which have three, as well as *Platysuchus*, *Bathysuchus*, *Teleosaurus* and *Sericodon* which are all reported to have five (Lamouroux, 1820; von Meyer, 1845; Eudes-Deslongchamps, 1869; Westphal, 1961; Westphal, 1962; Johnson et al., 2018; Schaefer et al., 2018). The first (P1) and second (P2) premaxillary alveoli are situated anterior to the third (P3) and fourth (P4), which are positioned posterolaterally. The fifth (P5) premaxillary alveolus (present in *Bathysuchus*, *Sericodon* and *Platysuchus*) is positioned dorsally in comparison to the P1 to P4 (Foffa et al., 2019). As such, the interalveolar distance varies between these alveoli. The P1 and P2 can be well separated in a way similar to that between the P3 and P4; the interalveolar spacing is large and noticeable, with the adjacent alveoli at a further distance from one another. This condition (state 0) occurs in *Platysuchus* (MNHNL TU895), *Sericodon* (SCR011-406 in Schaefer et al., 2018), *Bathysuchus* (DORCM G.05067i) and *Mycterosuchus* (CAMSM J.1420).

In contrast, in the majority of teleosauroids the P3 and P4 remain separate, but the P1 and P2 are situated closely together and are either separated by a small, thin interalveolar lamina, or appear slightly merged together, thereby creating a P1-P2 'couplet' (state 1). This state is seen in *Mystriosaurus* (NHMUK PV OR 14781), the Chinese teleosauroid (IVPP V 10098), *I. potamosiamensis* (PRC-11) and one subclade of teleosauroids ('*S*.' *bollensis* SMNS 18672; '*S*.' *leedsi*: NHMUK PV R 3806; *Deslongchampsina*: OUMNH J.29851; '*S*.' *heberti*: MNHN.F 1890-13; '*S*.' *edwardsi*: NHMUK PV R 2865; *Yvridiosuchus*: OUMNH J.1401; *Lemmysuchus*: NOTNH FS3361), excluding *Machimosaurus*. In *I. potamosiamensis* (PRC-11), '*S*.' *leedsi* (NHMUK PV R 3806) and the Chinese teleosauroid (IVPP V 10098), this interalveolar lamina between the P1-P2 is extremely thin.

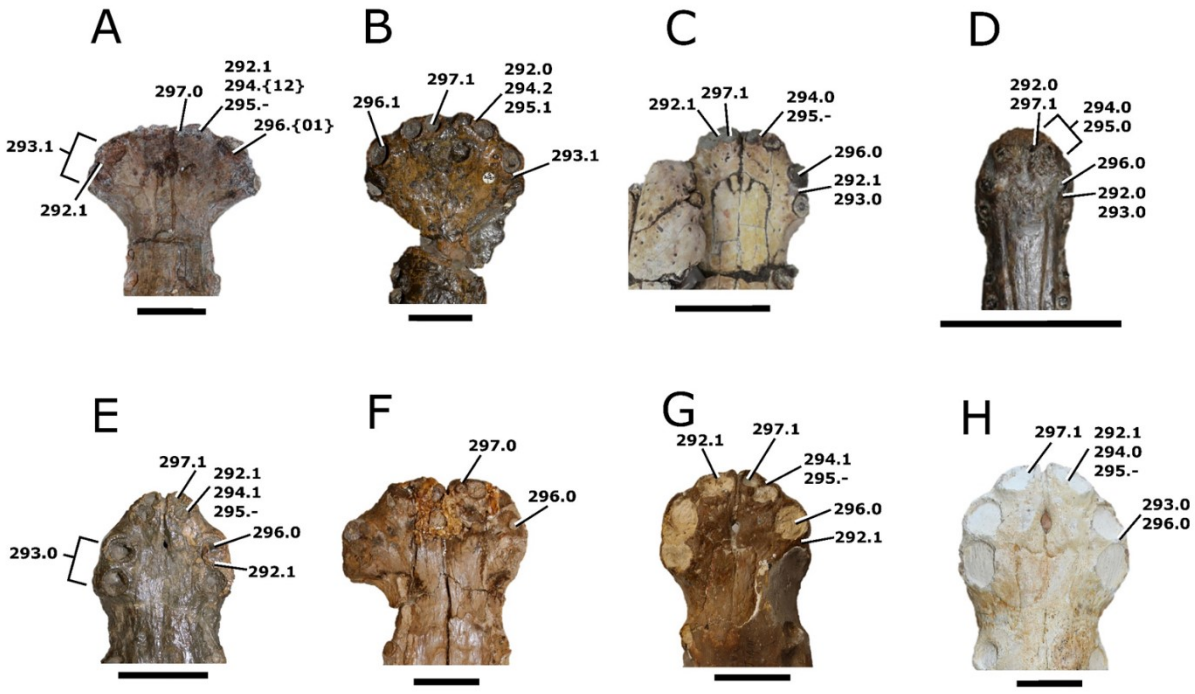


Figure 15. Comparative photographs displaying the characteristics of the premaxillary alveoli (ch. 292-297), in: (A) the Chinese teleosauroid (IVPP V 10098), (B), *Bathysuchus megarhinus* (DORCM G.05067i; Foffa et al., 2019), (C) *Indosinosuchus potamosiamensis* (PRC-11), (D) *Platysuchus multiscrobiculatus* (MNHNL. TU895), (E) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806), (F) *Mystriosaurus* sp. (SNHM-IG-008-R), (G) *Yvridiosuchus boutilieri* (OUMNH J.1401) and (H) *Lemmysuchus obtusidens* (LPP.M.21). Note that character 294 and 295 are inapplicable for the Chinese teleosauroid (IVPP V 10098). Scale bars: 3 cm.

Note that this character is not applicable for taxa that have fewer than four premaxillary alveoli; therefore, this character was inapplicable for the genus *Machimosaurus* (or the Teleosauroidea indeterminate Luxembourg specimen MNHNL TU164). The Chinese teleosauroid (IVPP V 10098) was initially thought to have three premaxillary alveoli (Li, 1993; Wilberg, 2015a), but in actuality, the P1 is very small, and a barely noticeable (due to poor preservation) interalveolar lamina separates it from the P2. Unfortunately, the anterior premaxilla is not preserved in either *S*. *rostromajor* (MNHN.RJN 134c-d) or '*S*.' *baroni* (NHMUK PV R 1999), two important fragmentary taxa that muddy the phylogenetic relationship between '*S*.' *edwardsi* and Machimosaurini. Johnson et al. (2017) briefly drew attention to the feature by examining it in *Lemmysuchus* (LPP.M.21; NOTNH FS3361). Foffa et al. (2019) then did so with *Bathysuchus* and closely related taxa; however, this character was not included in the supplementary files. This character is in connection with ch. **293**, **294** and **295**.

293. Premaxilla, the presence of a P3-P4 couplet is present (0) or absent (1) (Fig. 15).

In most teleosauroids, the interalveolar spacing is generally noticeable and well-developed between the P3 and the P4, but it is usually small (possibly due to both alveoli being quite large); the alveoli are therefore closely spaced together, forming a couplet (state 0). This is present in most teleosauroids (*Mystriosaurus*: NHMUK PV OR 14781; *I. potamosiamensis*: PRC-11; *Platysuchus*: MNHNL TU895; *Mycterosuchus*: CAMSM J.1420; '*S*.' *bollensis* SMNS 81699; '*S*.' *leedsi*: NHMUK PV R 3806; *Deslongchampsina*: OUMNH J.29851; '*S*.' *heberti*: MNHN.F 1890-13; '*S*.' *edwardsi*: NHMUK PV R 2865; *Yvridiosuchus*: OUMNH J.1401; *Lemmysuchus*: NOTNH FS3361). State 1 is found in both *Bathysuchus* (NHMUK PV OR 43086, DORCM G.05067i) and the Chinese teleosauroid (IVPP V 10098), in which the P3-P4 are widely spaced apart from one another, and therefore do not form a couplet.

As with ch. **292**, this character is not applicable for taxa (members of the genus *Machimosaurus*) that have fewer than four premaxillary alveoli. This character is in connection with ch. **292**, **294** and **295**.

294. Premaxilla in palatal view, both P1 and P2 are oriented anteriorly (0), P1 is oriented anteriorly and P2 slightly medially (1), or both P1 and P2 are oriented laterally (2) (Fig. 15).

The orientation of the first two premaxillary alveoli differs between certain teleosauroids, and may have certain phylogenetic inferences. In many teleosauroids, both the P1 and P2 are oriented anteriorly (state 0). This occurs in *Mystriosaurus* (NHMUK PV OR 14781), *I. potamosiamensis* (PRC-11), *Platysuchus* (MNHNL TU895), '*S.*' *bollensis* (SMNS 18672), *Deslongchampsina* (OUMNH J.29851), '*S.*' *edwardsi* (NHMUK PV R 28650, *Yvridiosuchus* (OUMNH J.1401) and *Lemmysuchus* (NOTNH FS3361). In a second condition (state 1), the P1 is oriented anteriorly, but the P2 is oriented slightly medially. This is seen in '*S.*' *leedsi* (NHMUK PV R 3806) and '*S.*' *heberti* (MNHN.F 1890-13). A third condition (state 2), which occurs in *Bathysuchus* (Foffa et al., 2019), *Sericodon* (SCR011-406 in Schaefer et al., 2018) and *Mycterosuchus* (CAMSM J.1420), is that the P1 and P2 are both strongly oriented laterally, appearing almost horizontally placed.

Foffa et al. (2019) initially noted that the positioning of premaxillary alveoli had phylogenetic importance, which was one of the factors contributing to the construction of this character. As with ch. **292**-**293**, this character is not applicable for taxa (members of the genus *Machimosaurus*) that have fewer than four premaxillary alveoli. This character is in connection with ch. **292**, **293** and **295**.

295. Premaxilla, both P1 and P2 do not form a couplet and are either not oriented on the anterior margin of the premaxilla (0) or are oriented on the anterior margin of the premaxilla (1) (Fig. 15).

In certain teleosauroids, if the P1-P2 alveolar complex does not form a couplet, these two alveoli are positioned either on or slightly ventral to the anterior margin of the premaxilla. In *Platysuchus* (SMNS 9930), the P1 and P2 do not form such a couplet and both alveoli are not oriented on the anterior margin of the premaxilla (state 0). However, in the genera *Bathysuchus* (DORCM G.05067i, unnumbered LPP specimen), *Sericodon* (SCR011-406 in Schaefer et al., 2018) and *Mycterosuchus* (CAMSM J.1420), the P1 and P2 do not form a couplet but are noticeably oriented on the anterior margin of the premaxilla (state 1).

As with ch. **292** to **294**, this character is not applicable for taxa that have fewer than four premaxillary alveoli (members of the genus *Machimosaurus*), or for taxa that have the P1-P2 alveolar couplet (e.g. *I. potamosiamensis*: PRC-11; the Chinese teleosauroid: IVPP V 10098; '*S.*' *heberti*: MNHN.F 1890-13; '*S.*' *edwardsi*: NHMUK PV R 2865; *Yvridiosuchus*: OUMNH J.1401). This character is in connection with ch. **292**, **293** and **294**. Foffa et al. (2019) initially described this character, but it was not included in the supplementary dataset.

296. Premaxilla with no strong lateral expansion (0) or strong lateral expansion so that P3 and P4 are aligned on the lateral plane of the external margin, more so than P2 (1) (Fig. 15).

In most teleosauroids, the P3 and P4 are positioned posteriorly to the P1 and P2, and are aligned on a vertical plane of the lateral margin, whereas the P1 and P2 are aligned more laterally. This is, in part, due to little or no lateral expansion of the premaxillae (state 0). This condition can be clearly seen in '*S.*' *gracilirostris* (NHMUK PV OR 14792), more basal teleosauroids such as *Mystriosaurus* (NHMUK PV OR 14781), *Platysuchus* (MNHNL TU895), *I. potamosiamensis* (PRC-11), *Teleosaurus* (Eudes-Deslongchamps, 1867-69), *Mycterosuchus* (CAMSM J.1420) and '*S.*' *bollensis* (SMNS 18672, SMNS 81699), and in more derived teleosauroids ('*S.*' *leedsi*: NHMUK PV R 3806; *Deslongchampsina*: OUMNH J.29851; '*S.*' *heberti*: MNHN.F 1890-13; '*S.*' *edwardsi*: NHMUK PV R 2865; *Yvridiosuchus*: OUMNH J.1401;

Lemmysuchus: LPP.M.21). In select taxa, the premaxillae are laterally expanded with the P3 and P4 aligned on a different plane (state 1). This occurs in *Bathysuchus* (DORCM G.05067i; unnumbered LPP specimen) and *Sericodon* (Schaefer et al., 2018).

Foffa et al. (2019) initially highlighted the lateral expansion seen in *Bathysuchus* (NHMUK PV OR 43086), but this character was not included in the supplementary files.

297. Premaxilla, very small first premaxillary alveolus with the second premaxillary alveolus being much larger (0) or the first and second premaxillary alveoli are relatively the same size (1) (Fig. 15).

In most teleosauroids, the size of the P1 and P2 are relatively the same, with both being slightly smaller than the P3 and P4 (which is often the largest, as it houses the large fourth premaxillary tooth) (state 1). This condition is observed in *I. potamosiamensis* (PRC-11), *Mycterosuchus* (CAMSM J.1420), *Bathysuchus* (DORCM G.05067i), *Deslongchampsina* (OUMNH J.29851), '*S.*' *leedsi* (NHMUK PV R 3806), '*S.*' *heberti* (MNHN.F 1890-13), '*S.*' *edwardsi* (NHMUK PV R 2865), *Yvridiosuchus* (OUMNH J.1401) and *Lemmysuchus* (LPP.M.21). In both *Deslongchampsina* (OUMNH J.29815) and *Yvridiosuchus* (OUMNH J.1401), the P1 is slightly smaller than the P2, but not substantially so.

In certain teleosauroids, the P1 is considerably smaller than the P2, with the P1 being 25% or less the size of the P2 (state 0). This condition is observed in the Chinese teleosauroid (IVPP V 10098) and '*S.*' *bollensis* (SMNS 81699). It is also interesting to note that this feature is also clearly displayed in SNHM-IG-008-R, a taxon referred to as '*Steneosaurus*' aff. *bollensis* (that is currently thought to belong to the genus *Mystriosaurus*; MMJ, pers. obs.). However, this specimen is still currently being worked on and scored (by colleagues and myself), and is therefore currently not included in the dataset. In addition, the entirety of the P1 and P2 of both verified *Mystriosaurus laurillardi* specimens (HLMD V946-948; NHMUK PV

OR 14781: Sachs et al., 2019b) cannot be seen to confirm this. As with ch. **292** to **295**, this character is not applicable for taxa with fewer than four premaxillary alveoli (members of the genus *Machimosaurus*).

339. Dentition, the presence of carinae on the apical third of a tooth is present and well pronounced (0) or absent/weakly pronounced (1) (Fig. 16).

The overall definition, as well as the appearance, of carinae differs with respect to true-ziphodont (all teeth possess serrated or denticulated carinae) or false-ziphodont (noticeable superficial enamel ornamentation contacts the keel) dentition. In general, carinae are defined as sharp, narrow ridges or 'keels' running apicobasally along the crown, representing the cutting edge of the tooth. Carinae can be observed in the dentition of theropods (Currie, 1995; Buffetaut et al., 2008; Hendrickx et al., 2015), various crocodylomorphs (Prasad & Broin, 2002; Andrade & Bertini, 2008; Andrade et al., 2010), mosasaurs (Lindgren, 2005; Jagt et al., 2005; Grigoriev, 2014) and some ichthyosaurs (Fischer et al., 2011). At times, carinae can be difficult to distinguish from enamel ridges (Young & Steel, 2014).

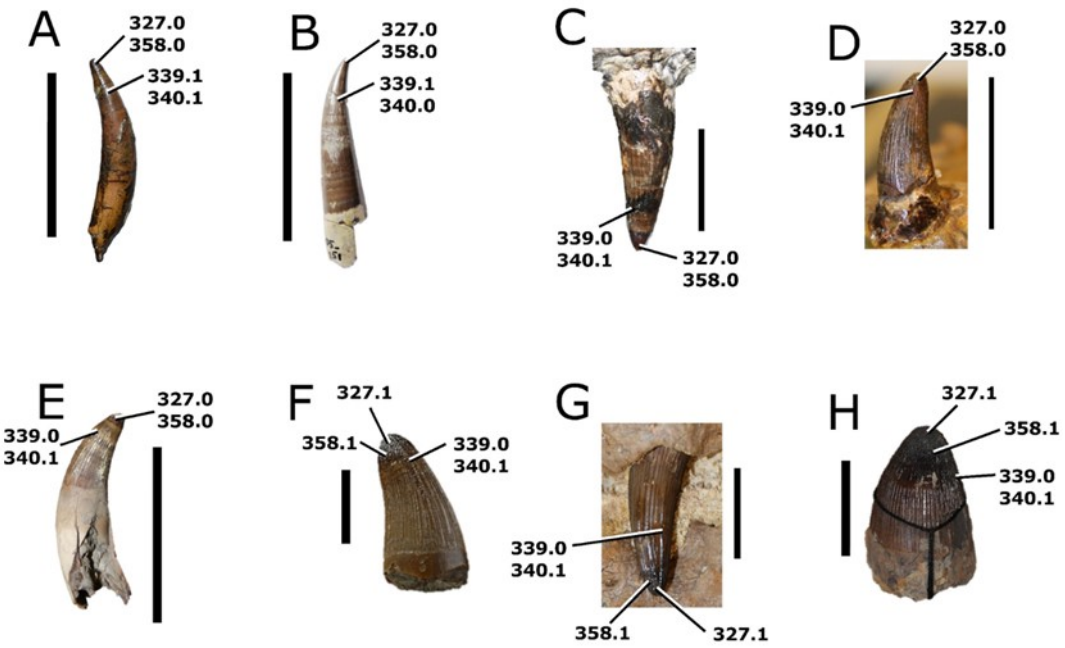


Figure 16. Comparative photographs of teleosauroid dentition, highlighting the carine (ch. 339-340), apices (ch. 327) and presence/absence of an anastomosing pattern (ch. 358): (A) *Bathysuchus megarhinus* (DORCM G.05067iv; Foffa et al., 2019), (B) *Sericodon jugleri* (TCH005-151; Shaefer et al., 2018), (C) '*Steneosaurus*' *heberti* (MNHN.F 1890-13), (D) *Deslongchampsina larteti* (OUMNH J.29851), (F) '*Steneosaurus*' *edwardsi* (NHMUK PV R 2865), (F) Machimosaurini indeterminate (GPIT-RE-301), (G) *Yvridiosuchus boutilieri* (OUMNH J.29850), and (H) *Machimosaurus hugii* (MG 25). Scale bars: 3 cm (A-B, E) and 1 cm (C-D, F-H).

All known teleosauroids possess carinae (excluding the Chinese teleosauroid IVPP V 10098, '*S.*' *baroni* NHMUK PV R 1999, '*S.*' *stephani* NHMUK PV OR 49126 and '*S.*' *bouchardi* [Lepage et al., 2008], as none have any teeth preserved); however, the relative noticeability of these ridges differs between taxa. The carinae of '*S.*' *gracilirostris* (MNHNL TU515), *Mystriosaurus* (NHMUK PV OR 14781), *Platysuchus* (SMNS 9930), *Bathysuchus* (DORCM G.05067iv) and '*S.*' *bollensis* (SMNS 51563) are fine and faint, whereas those of '*S.*' *edwardsi* (PETMG R178) and machimosaurins (*Yvridiosuchus*: OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3168; *Mac. buffetauti*: SMNS 91415) are well-developed. In addition, most teleosauroids have carinae that extend the entire apicobasal length of the tooth, (state 0). These is seen in the basal form '*S.*' *gracilirostris* (MNHNL TU515) and *Mystriosaurus* (NHMUK PV OR 14781), *Indosinosuchus* sp. (PRC-239), *Mycterosuchus* (NHMUK PV R 2617),

Aeolodon (MNHN.F.CNJ 78) '*S.*' *leedsi* (NHMUK PV R 3806), '*S.*' *heberti* (MNHN.F 1890-13) '*S.*' *megistorhynchus* (OUMNH J.1414), *S. edwardsi* (PETMG R178), *Lemmysuchus* (NHMUK PV R 3168) and *Mac. hugii* (MG-8730-1). However, two taxa (*Bathysuchus*: DORCM G.05067iv; *Sericodon*: TCH005-151 in Schaefer et al., 2018) have carinae that only extend two-thirds the apicobasal length of the tooth and are absent at the apex, from the base to the apex and are absent at the apex (state 1).

340. Dentition, the presence of enamel ridges on the apical third of a tooth is absent (0) or present (1) (Fig. 16).

Enamel ridges, or wrinkles, are elongated, thin, apicobasally oriented crenulations that cover the near-entirety of the enamel surface of the tooth. They generally run parallel to one another, flank the carinae on either side and follow the curvature of the tooth. It is unclear what purpose they serve, whether it be a mechanical role associated with feeding or a by-product of tooth growth (Brusatte et al., 2007). In teleosauroids, the enamel ridges are either faint and/or difficult to see (e.g. '*S.*' *gracilirostris*: MNHNL TU515), or noticeable and well-developed (e.g. *Mycterosuchus*: NHMUK PV R 2617). In most teleosauroids (including the basal taxon '*S.*' *gracilirostris*), the basal four-fifths of these ridges are generally numerous, continuous from the base and aligned parallel with one another. In machimosaurins (*Yvridiosuchus*: OUMNH J.29851; *Lemmysuchus*: NHMUK PV R 3168; *Mac. buffetauti*: SMNS 91415; *Mac. hugii* MG-8730-1; *Mac. rex*: ONM NG 7), at the apical fifth these ridges abruptly change, becoming shorter and randomly spaced in an anastomosed pattern (see ch. **358** below). Enamel ridges are present on the entirety of the crown, including the apex (state 1) in the basal-most form '*S.*' *gracilirostris* (MNHNL TU515) along with most teleosauroids (*Mystriosaurus*: NHMUK PV OR 14781; *Indosinosuchus* sp.: PRC-239; *Mycterosuchus*: NHMUK PV R 2617; *Bathysuchus*: DORCM G.05067iv; *Aeolodon*: MNHN.F.CNJ 78; '*S.*' *bollensis*: SMNS 53422; '*S.*' *leedsi*: NHMUK PV R 3806; '*S.*' *megistorhynchus*: OUMNH J.1414; *Deslongchampsina*: OUMNH J.29851; '*S.*' *edwardsi*: PETMG R178; machimosaurins: OUMNH J.29850, NHMUK PV R 3168; NHMW 1846.III.208). In '*S.*' *heberti* (MNHN.F

1890-13), the teeth appear to have enamel ridges that reach the apices, but many are covered in a thin coating of adhesive substance, so it is difficult to tell if they are either poorly or well developed; therefore, this taxon has been scored as {01}. Only one confirmed taxon, *Sericodon* (TCH005-151 in Schaefer et al., 2018), are the enamel ridges absent from the apex (state 0). However, it is interesting to note that an unnumbered MNHN '*Steneosaurus*' sp. and unnumbered NHMW '*Teleosaurus*' also display state 0.

394. Cervical ribs in lateral view, the anteroposterior ridge of large, more posteriorly placed cervical ribs is straight (0) or dorsoventrally curved (1) (Fig. 17).

Most teleosauroids that can be scored for this character exhibit T-shaped (in dorsal view) cervical ribs where the anteroposterior ridge is horizontal or straightened (state 0), which is observed in all of the ribs, including the larger, posterior ones. Taxa with state 0 include *Platysuchus* (SMNS 9930), *Mycterosuchus* (NHMUK PV R 2617), '*S.*' *leedsi* (NHMUK PV R 3806) and '*S.*' *edwardsi* (PETMG R178). However, in *Lemmysuchus* (NHMUK PV R 3168), the largest, most posteriorly placed cervical ribs have a distinct dorsomedial curvature along the anteroposterior ridge, appearing slightly concave in lateral view (state 1). It is unclear if this is a synapomorphy for Machimosaurini: in *Mac. mosae* (Hua, 1999), the cervical ribs are partially preserved, and it is not clear if these are the more anterior or posteriorly placed ones (the larger posterior cervical ribs on the IRSNB *Mac. mosae* cast appear to be curved). Seven cervical ribs are preserved in *Mac. buffetauti*, with the largest one being anteroposteriorly straight (more similar to *S. edwardsi*: PETMG R178; '*S.*' *leedsi*: NHMUK PV R 3806; *Platysuchus*: SMNS 9930). Note that this character was initially described and figured in Johnson et al. (2017).

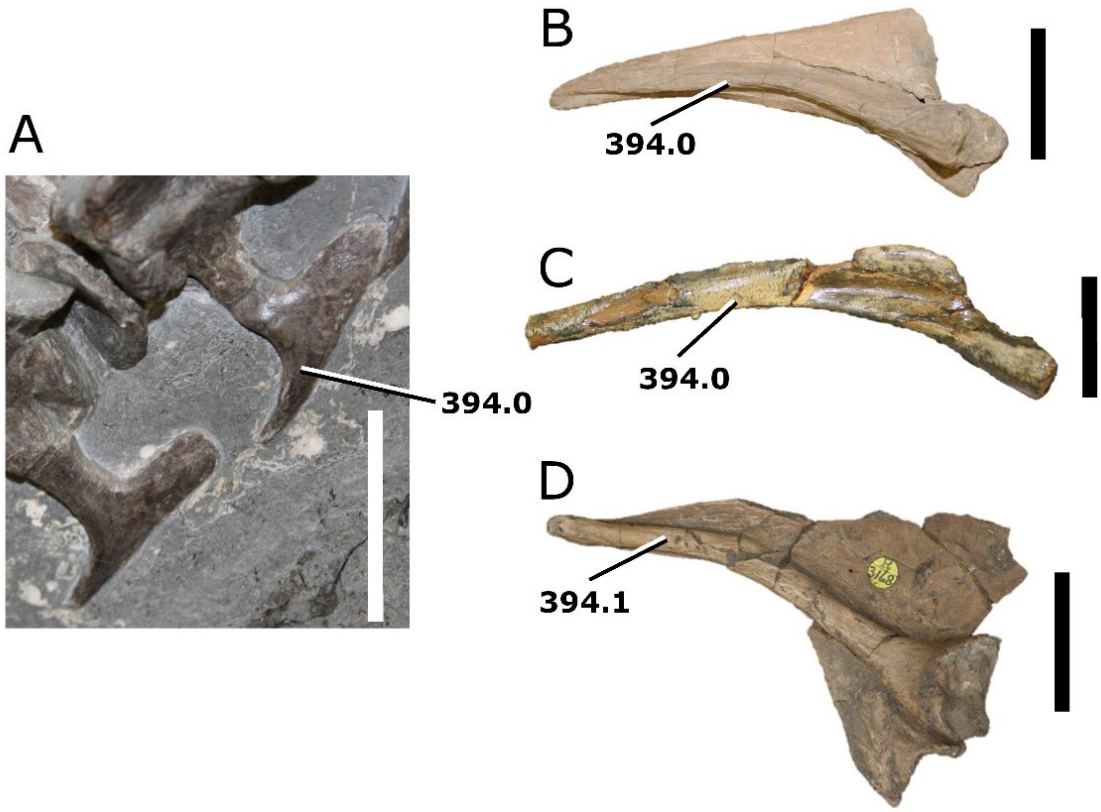


Figure 17. Comparative photographs of teleosauroid cervical ribs (ch. 394): (A) '*Steneosaurus*' *bollensis* (SMNS 51984), (B) *Mycterosuchus nasutus* (NHMUK PV R 2617), (C) '*Steneosaurus' edwardsi* (NHMUK PV R 3701) and (D) *Lemmysuchus obtusidens* (NHMUK PV R 3168). Scale bars: 3 cm.

395. Dorsal ribs, the positioning of both the tuberculum and articular facet is on the medial edge (0), directly in the middle (1), or on the lateromedial edge (2) (Fig. 18).

The tuberculum, located on the posterior surface of the dorsal (thoracic) rib, is a relatively small protrusion that articulates with the opposite facet located on the transverse process of the same numbered vertebra. In contrast, the flattened articular facets are separated from the top of the tuberculum; these bony knobs are divided into superior (top) and inferior (bottom) surfaces, which are placed close together and articulate with the adjoining facet on the vertebral processes.

In most teleosauroids with preserved dorsal ribs, both the tuberculum and articular facets positioned on the medial edge of the rib (state 0). This is observed in *Platysuchus* (SMNS 9930), '*S*.' *bollensis* (SMNS 51753, SMNS 18672), *Aeolodon* (MNHN.F.CNJ 78) and *Lemmysuchus* (NHMUK PV R 3168). In two taxa (*Mycterosuchus*: NHMUK PV R 2617; '*S*.' *leedsi*: NHMUK PV R 3806), the tuberculum and articular facets have shifted laterally and are placed directly in the middle of the rib (state 1). In '*S*.' *edwardsi* (NHMUK PV R 3701, PETMG R178), the tuberculum and articular facets have shifted even further laterally so that they are positioned on the lateromedial edge of the rib (state 2). In *Mac. buffetauti* (SMNS 91415), there are approximately twelve dorsal ribs present, but few are complete with a relatively well preserved rib head (which includes the capitulum, articular facets and tuberculum). In addition, it is difficult to confidently locate where these surfaces are positioned in the dorsal rib of *Sericodon* (SCR010-312 in Schaefer et al., 2018), but they appear to be either medially or lateromedially placed.

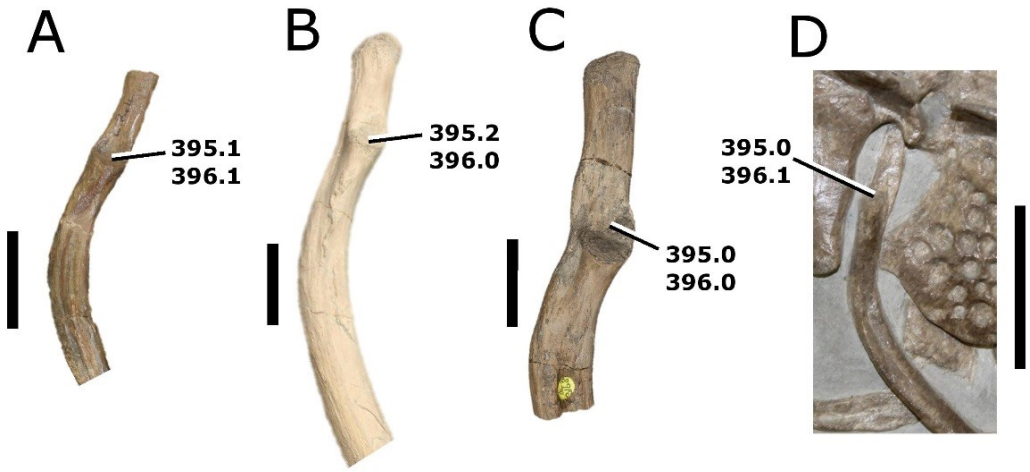


Figure 18. Comparative photographs of teleosauroid dorsal ribs (ch. 395-396) (from the middle of the ribcage); (A) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806), (B) '*Steneosaurus*' *edwardsi* (PETMG R178), (C) *Lemmysuchus obtusidens* (NHMUK PV R 3168) and (D) '*Steneosaurus*' *bollensis* (SMNS 52034). Scale bars: 3 cm.

396. Dorsal rib in lateral view, the tuberculum is pronounced (0) or shallow (1) (Fig. 18).

As mentioned in ch. **395**, the tuberculum is a relatively reduced protrusion on the proximal half of the dorsal (thoracic) rib. However, the size of the tuberculum changes drastically in teleosauroids, particularly in the largest dorsal ribs. In the genera *Mycterosuchus* (NHMUK PV R 2617), '*S.*' *edwardsi* (PETMG R178), *Lemmysuchus* (NHMUK PV R 3168) and *Mac. buffetauti* (SMNS 91415), the tuberculum is well-developed and pronounced, as large as the capitulum and anteroposteriorly elongated, giving it an oval shape (state 0). In certain taxa (*Sericodon*: Schaefer et al. 2018; *Aeolodon*: MNHN.F.CNJ 78; '*S.*' *bollensis*: SMNS 51753; '*S.*' *leedsi*: NHMUK PV R 3806), the tuberculum is reduced, small and circular in shape (state 1). In this state, it is much smaller than the capitulum; this is well exemplified in '*S.*' *leedsi* (NHMUK PV R 3806). In *Platysuchus* (SMNS 9930), the tubercula of the anterior dorsal ribs are pronounced; however, in the middle to posterior ribs most of the rib heads are covered by osteoderms, although the tuberculum appears to be relatively reduced compared to the anterior ones. Due to this uncertainty, *Platysuchus* was scored as {01}. Johnson et al. (2017) first noted and figured this feature, specifically focusing on the differences between *Lemmysuchus* (NHMUK PV R 3168), '*S.*' *leedsi* (NHMUK PV R 3806) and '*S.*' *edwardsi* (NHMUK PV R 3701).

398. Second sacral vertebrae, the anterior margin of the posterior area of the second sacral vertebra has either a small, non-expanding flange (0) or a large, expanded and projecting flange (1) (Fig. 19).

In crocodylomorphs, the posterior area of the second sacral vertebra displays an anterior margin that is both anteroposteriorly and dorsoventrally expanded into a projection or 'flange' of bone, which allows for a secure attachment to the ilium, thus influencing body movement. This 'flange' is either small and non-expanding (state 0), or noticeably expanded and anteroposteriorly protruding (state 1). All scored teleosauroids exhibit state 1, as there is always an expanded flange present on the anterior margin; however, the size and development differs. In the taxa *Mycterosuchus* (NHMUK PV R 2617), '*S.*' *leedsi* (NHMUK PV R 3806), *Lemmysuchus* (NHMUK PV R 3168) and *Mac. mosae* (Hua, 1999; Young et al., 2014a), the flange is considerably

larger, more pronounced and well-developed. In '*S.*' *bollensis* (MMG BwJ 595) and '*S.*' *edwardsi* (NHMUK PV R 3701) the flange is still present, but it is much smaller and less obvious. This character was initially described and figured in Johnson et al. (2017).

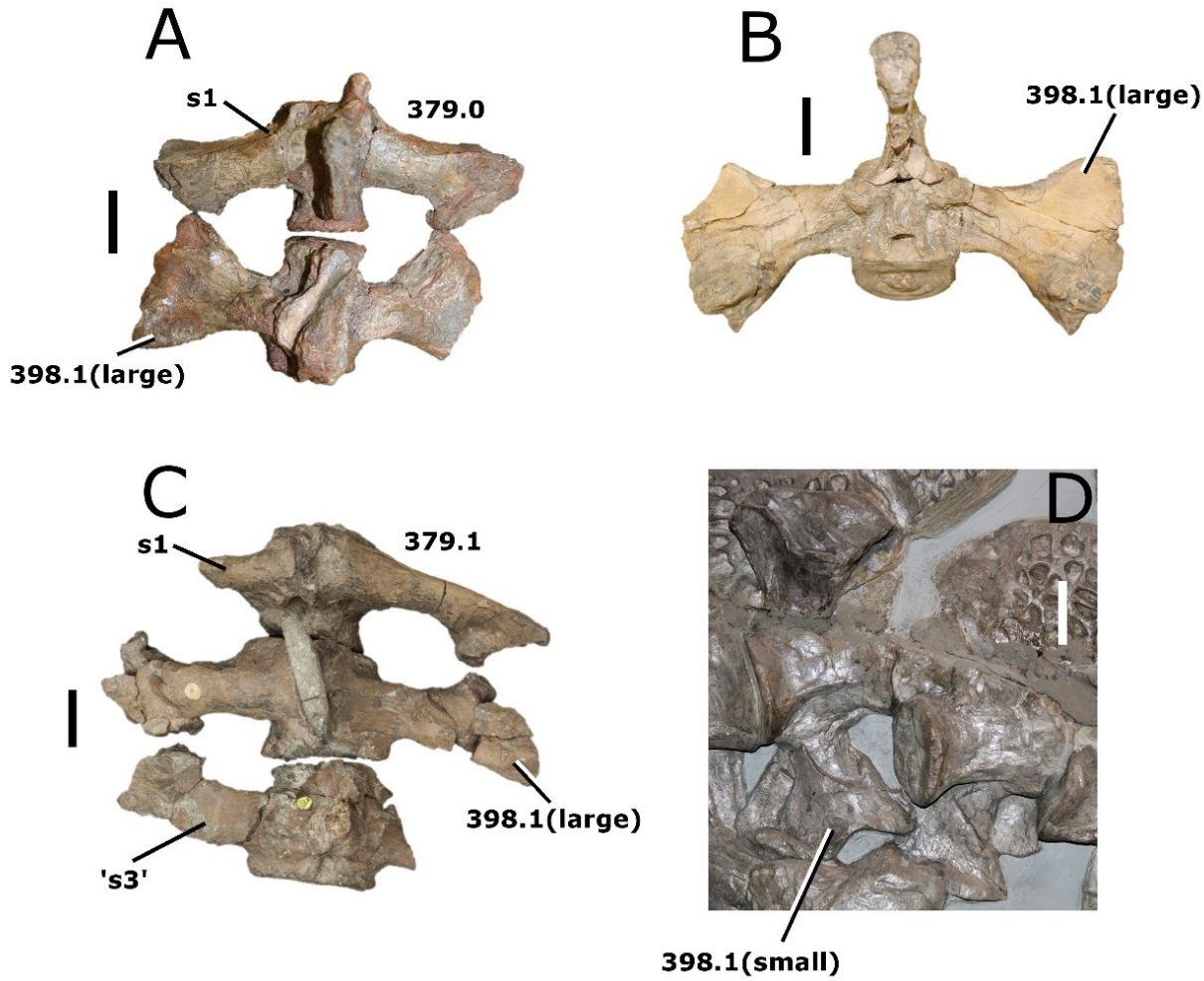


Figure 19. Comparative photographs of teleosauroid sacral vertebrae, with special attention to the number (ch. 379) and flange of the second sacral (ch. 398): (A) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806), (B) *Lemmysuchus obtusidens* (NHMUK PV R 3168), (C) *Mycterosuchus nasutus* (NHMUK PV R 2617) and (D) '*Steneosaurus*' *bollensis* (GPIT-RE-9427).

417. Radius and ulna, the same length (0) or the ulna is longer (1) (Fig. 20).

The radius and ulna are two bones of the forelimb; they articulate proximally with the humerus and distally with the carpal (wrist) bones. In teleosauroids, the radius is a straight, squat, unornamented bone with a slightly expanded head that is positioned laterally; in contrast, the ulna is noticeably proximally expanded with a flattened, dorsoventrally elongated olecranon process, and is positioned medially. The radius and ulna articulate with one another; the radial head has a small facet for articulation with the ulna. In the majority of teleosauroids, the radius and ulna are approximately the same size (Andrews, 1913), with the ulna being marginally larger; this is seen in taxa such as *Platysuchus* (SMNS 9930), *Aeolodon* (MNHN.F.CNJ 78), '*S.*' *bollensis* (SMNS 51563, SMNS 53422), '*S.*' *leedsi* (NHMUK PV R 3608), '*S.*' *edwardsi* (PETMG R178) and *Lemmysuchus* (NHMUK PV R 3168). However, in the genus *Mycterosuchus* (NHMUK PV R 2617) the ulna is roughly 18% longer than the radius, which is unusual. While Andrews (1913) did note the large radius and ulna of *Mycterosuchus* relative to other '*Steneosaurus*' species, the relation between the two bones was not included in his observations.

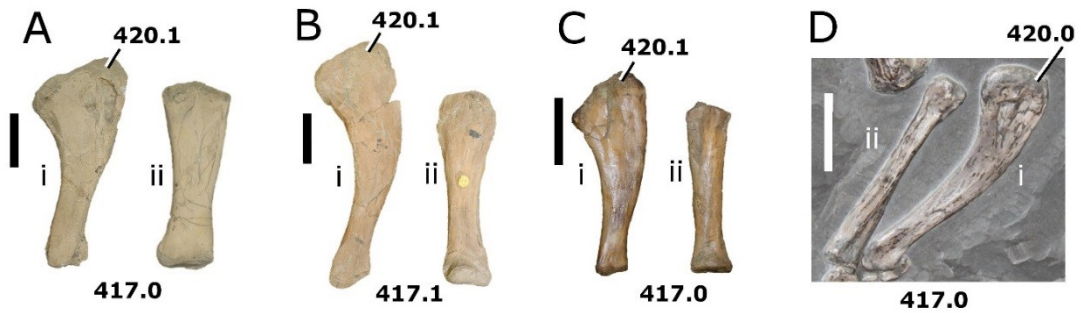


Figure 20. Comparative photographs of teleosauroid ulnae and radiae, with special attention to relative size (ch. 417) and proximal ulna (ch. 420): (A) '*Steneosaurus*' *edwardsi* (PETMG R178) i. ulna and ii. radius; (B) *Mycterosuchus nasutus* (NHMUK PV R 2617) i. ulna and ii. radius; (C) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806) i. ulna and ii. radius; and (D) '*Steneosaurus*' *bollensis* (SMNS 53422) i. ulna and ii. radius. Scale bars: 3 cm.

430. Pubis, the shape of distal rim of distal pubic blade is straight and square-like (0) or curved and rounded (1) (Fig. 21).

The pubis is one of the three bones of the hip, and is divided into three distinct parts: (i) the pubic head, a rounded proximal knob of bone that articulates with the ischium and ilium; (ii) the pubic shaft, the middle of the bone; and (iii) the pubic plate (=blade), a distally directed, flattened expansion of bone. This character examines the distal rim of the pubic blade, taking into account its shape and appearance. In most scored teleosauroids, the ventral (distal) margin of the pubic blade is anteriorly curved and rounded in lateral view (state 1). This is the case in '*S*.' *leedsi* (NHMUK PV R 3806), '*S*.' *bollensis* (SMNS 51957), '*S*.' *edwardsi* (PETMG R178), *Lemmysuchus* (NHMUK PV R 3168) and *Mac. mosae* (Hua, 1999; Young et al., 2014a). However, in two taxa the distal rim of the pubic blade is straightened and relatively square-like (state 0): *Mycterosuchus* (NHMUK PV R 2617) and *Platysuchus* (SMNS 9930).

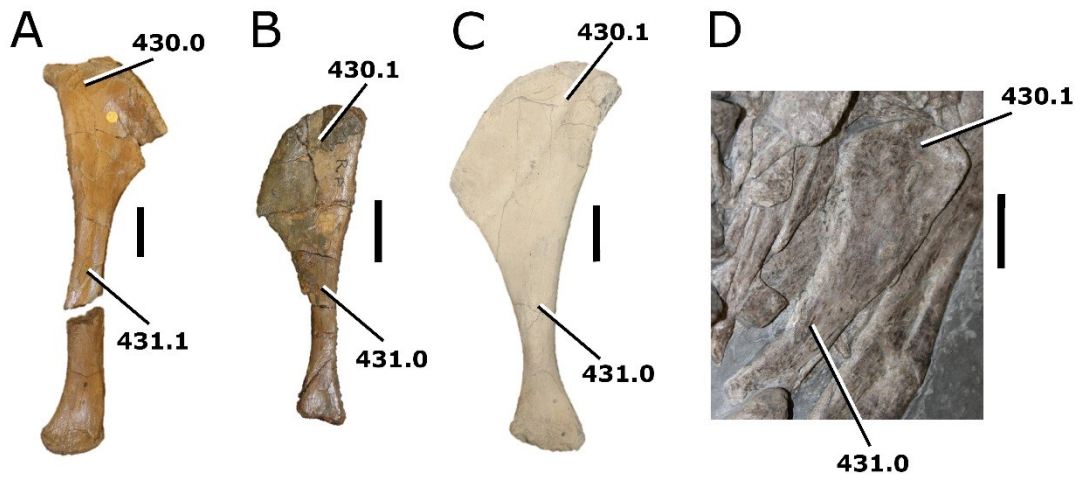


Figure 21. Comparative photographs of teleosauroid pubes, highlighting the pubic blade (ch. 430) and elongation (ch. 431): (A) *Mycterosuchus nasutus* (NHMUK PV R 2617), (B) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806), (C) '*Steneosaurus*' *edwardsi* (PETMG R178) and (D) '*Steneosaurus*' *bollensis* (SMNS 51957). Scale bars: 3 cm.

431. Pubis, the pubic shaft is shorter (0) or longer (1) than the pubic blade (Fig. 21).

As stated previously, the pubis is one of the hipbones and is divided into three parts, the pubic head, the pubic shaft and the pubic blade (=pubic plate). The pubis is relatively anteroposteriorly elongated in teleosauroids,

and both the pubic shaft and pubic blade represent a significant part of this elongation. In the majority of taxa, the pubic shaft is either approximately the same length or slightly anteroposteriorly shorter than the pubic blade (state 0). This is the condition seen in six scored teleosauroids: '*S.*' *bollensis* (SMNS 51957), '*S.*' *leedsi* (NHMUK PV R 3806), *Lemmysuchus* (NHMUK PV R 3168), *Mac. mosae* (Hua, 1999), *Platysuchus* (SMNS 9930) and *Sericodon* (SCR010-312 in Schaefer et al., 2018). However, the pubic shaft is significantly longer (over 50%) than the pubic blade (state 1) in one taxon (*Mycterosuchus*: NHMUK PV R 2617) and represents an apomorphic trait of this genus. A longer, lankier pubis may also have an effect on pelvic girdle aspiration; in modern crocodilians, the pubic bones are highly mobile and can be rotated using pelvic and hypaxial muscles as an 'aspiration pump' (Rathke, 1866; Farmer & Carrier, 2000; Claessons, 2004).

434. Ilium, the anterior iliac process is long and slender (0), or short and robust (1) (Fig. 22).

The anterior process, or preacetabular, is a projection of bone situated on the anterodorsal rim of the ilium. In most teleosauroids, this process is anteroposteriorly elongated, mediolaterally slender, and straight with little to no curvature (state 0). This is seen in *Platysuchus* (SMNS 9930), *Teleosaurus* (NHMUK PV R 1782a), *Sericodon* (SCR010-312 in Schaefer et al., 2018), *Aeolodon* (MNHN.F.CNJ 78), '*S.*' *bollensis* (MMG BwJ 565), '*S.*' *leedsi* (NHMUK PV R 3806; Andrews, 1913) and '*S.*' *edwardsi* (PETMG R178). In contrast, state 1 describes the anterior process as anteroposteriorly shortened, robust and chunky in appearance, with a slight lateral curvature. This morphology is present in the machimosaurins *Lemmysuchus* (NHMUK PV R 3168) and *Mac. mosae* (Hua, 1999; Young et al., 2014a), as well as the basal metriorhynchoid *Pelagosaurus* (MNHN.RJN 463) and members of Metriorhynchidae (e.g. *Tyrannoneustes lythrodectikos* Young et al., 2013; *Cricosaurus lithographicus*; *Cricosaurus araucanensis* [Herrera et al., 2013c]; Fraas, 1902; Andrews, 1913). The shortening and general robustness of the ilium in machimosaurins may be due to living in a higher energy environment,

or may be indicative of more terrestrial movement. Johnson et al. (2017) described and figured this character specifically in machimosaurins.

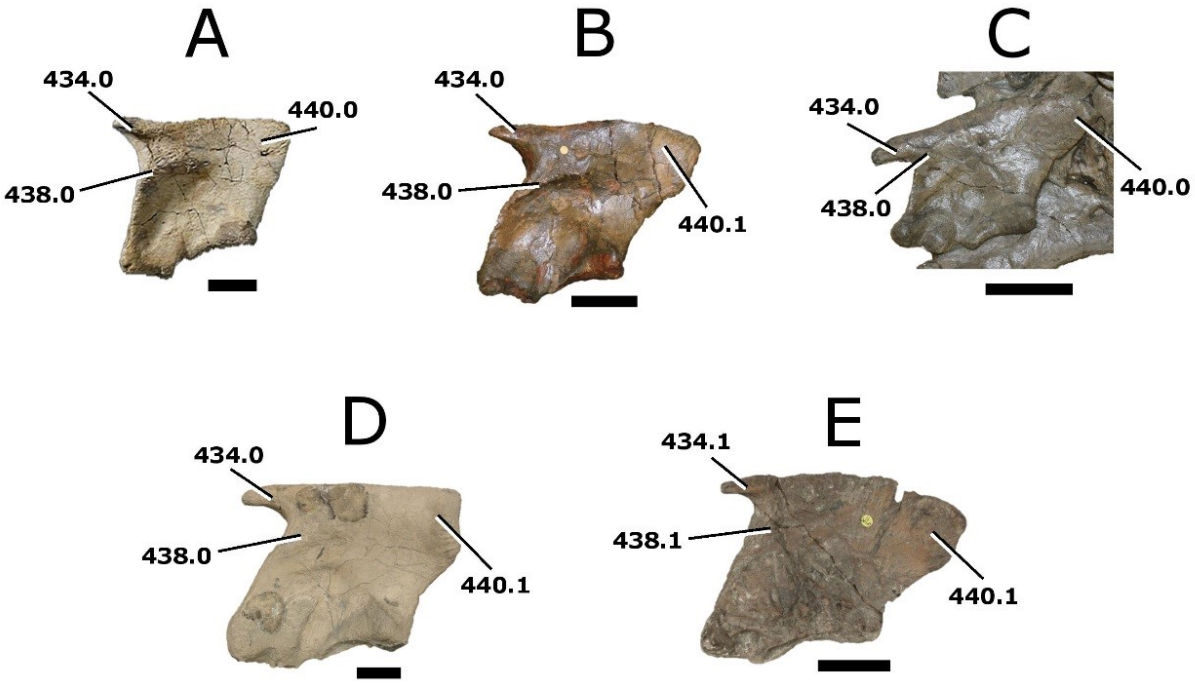


Figure 22. Comparative photographs of teleosauroid ilia with attention to the anterior process (ch. 434), postacetabular process (440) and supraacetabular crest (ch. 438): (A) *Sericodon jugleri* (SCR010-312; Schaefer et al., 2018), (B) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806), (C) '*Steneosaurus' bollensis* (SMNS 18672), (D) '*Steneosaurus*' *edwardsi* (PETMG R178) and (E) *Lemmysuchus obtusidens* (NHMUK PV R 3168). Scale bars: 5 cm.

438. Supraacetabular iliac crest is pronounced (0) or shallow and poorly developed (1) in medial view (Fig. 22).

The supraacetabular iliac crest, observed in medial view, is a projection of bone that runs along the anterior margin of the acetabulum. In non-machimosaurins ('*S.*' *gracilirostris*: NHMUK PV OR 14792; *Platysuchus*: SMNS 9930; *Teleosaurus*: NHMUK PV R 1782a; *Sericodon*: SCR010-312 in Schaefer et al., 2018; '*S.*' *bollensis*: SMNS 51984; '*S.*' *leedsi*: NHMUK PV R 3806; '*S.*' *edwardsi*: NHMUK PV R 3701, PETMG R178) the supraacetabular crest is enlarged and pronounced, jutting out laterally and slightly overhanging the acetabulum (state 0). In state 1, the supraacetabular crest is poorly developed, with either shallow or no outward projection. This is the case in the machimosaurins *Lemmysuchus* (NHMUK PV R 3168; Johnson et

al., 2017) and *Mac. mosae* (Hua, 1999). In addition, the supraacetabular crest in state 1 is anteroposteriorly short and its posterior extension along the anterior margin of the acetabulum varies between taxa. For example, in *Lemmysuchus* (NHMUK PV R 3168), the supraacetabular crest is greatly reduced with very little posterior extension; it is difficult to even distinguish from the acetabulum (although this may be due to poor preservation).

449. Ischium, the posteroventral margin of ischial blade is triangular (0) or sub-square (1) (Fig. 23).

The ischial blade (=plate) is an expanded, mediolaterally flattened sheet of bone that makes up the distal area of the ischium. In most teleosauroids, the ischial blade is gracile, mediolaterally thin and anteroposteriorly elongated, with the posteroventral margin having a triangular-like shape (state 0). This morphology is present in *Platysuchus* (SMNS 9930), *Teleosaurus* (NHMUK PV R 1638), *Mycterosuchus* (CAMSM J.1420), '*S.*' *bollensis* (SMNS 51957), '*S.*' *leedsi* (NHMUK PV R 3806) and '*S.*' *edwardsi* (NHMUK PV R 3701, PETMG R178). A second condition (state 1) is that the posteroventral margin is noticeably anteroposteriorly shortened and dorsoventrally broad, giving it a sub-square shape. This state is unique to machimosaurins (*Lemmysuchus*: NHMUK PV R 3168; *Mac. mosae*: ISRNB cast; Hua, 1999; Young et al., 2014a). Wilkinson et al (2008) first took note of this feature in a metriorhynchid ilium (*Torvoneustes carpenteri* Wilkinson et al., 2008), and Johnson et al. (2017) described and figured it in relation to teleosauroids (specifically *Lemmysuchus* and closely related taxa).

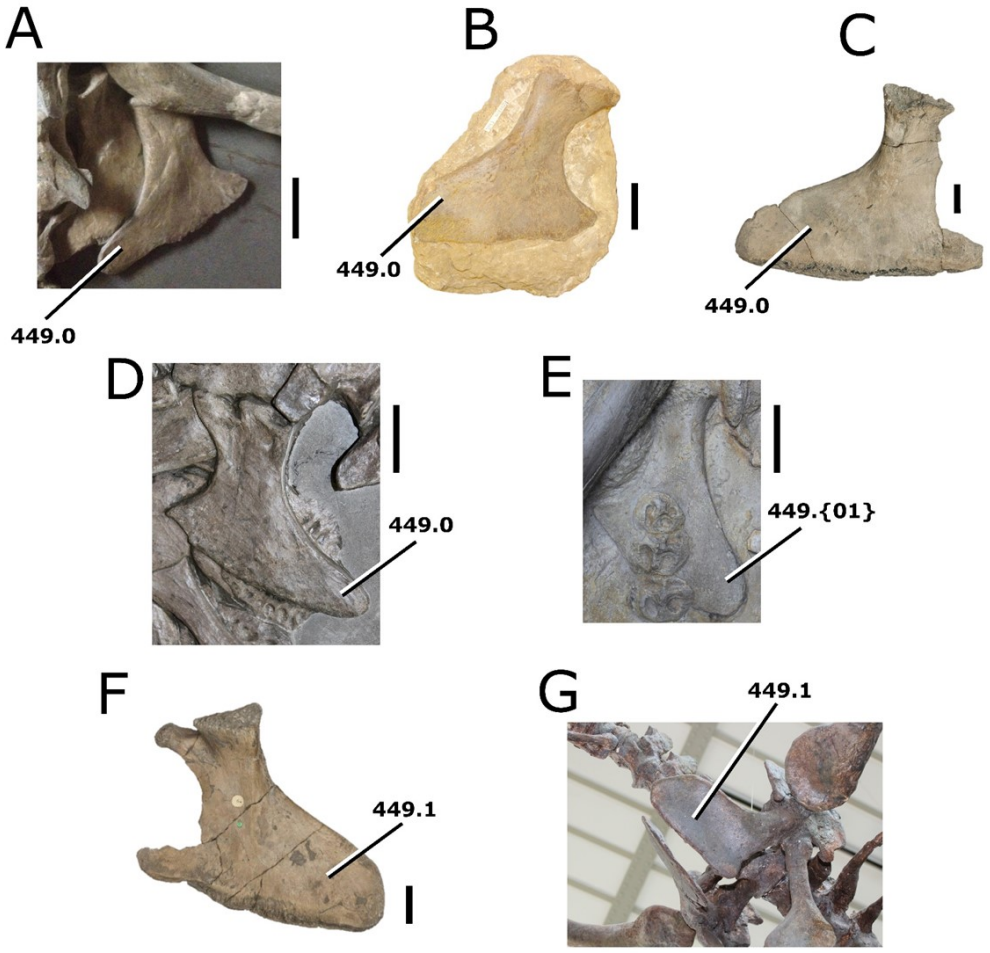


Figure 23. Comparative photographs of teleosauroid ischia with emphasis on the ischial blade (ch. 449): (A) *Platysuchus multiscrobiculatus* (SMNS 9930), (B) *Teleosaurus* sp. (NHMUK PV 238), (C) '*Steneosaurus*' *edwardsi* (NHMUK PV R 3898), (D) '*Steneosaurus*' *bollensis* (SMNS 58876), (E) *Aeolodon priscus* (MNHN.F.CNJ 78), (F) *Lemmysuchus obtusidens* (NHMUK PV R 3168) and (G) *Machimosaurus mosae* (IRSNB cast). Scale bars: 3 cm, (H) not to scale.

When examining all bones of the pelvis, there appear to be two distinct morphotypes in teleosauroids: the slender, more gracile morphotype (e.g. '*S.*' *leedsi*) and the stocky, robust morphotype (e.g. *Lemmysuchus*). The general shortening and robustness of the pelvis in certain teleosauroids may be due to living in a higher energy or more terrestrial environments, as mentioned previously (Johnson et al., 2017). In addition, a stockier pelvis may also have an effect on pelvic girdle aspiration: in modern alligators, the pubic bones are rotated using pelvic and hypaxial muscles, which increase lung ventilation (Claessens, 2004). A decrease in surface area for pelvic muscle attachment may indicate less reliance on pelvic girdle aspiration, and more so on diaphragmatic and costosternal breathing.

456. Femur in dorsal view, the anteromedial tuber is present and small (0), or the largest of the proximal tubera (1) (Fig. 24).

The femora of teleosauroids have historically been regarded as relatively similar throughout the entirety of the group (Andrews, 1909, 1913). However, there are some subtle yet key differences in femoral anatomy between genera. One of these characters focusses on the anteromedial tuber of the proximal femoral head, which articulates with the acetabulum of the ilium. There are three tubera present on the head of the femur: the anteromedial, posteromedial and anterolateral tubera. The presence of a proximal anteromedial tuber is a characteristic synapomorphy for all Archosauria (Nesbitt, 2011), and the posteromedial tuber is generally the largest of the three.

In most teleosauroids, the posteromedial tuber remains the largest, and the anteromedial tuber is present but relatively small (state 0). This is the condition seen in *Platysuchus* (SMNS 9930), *Sericodon* (SCR010-312 in Schaefer et al., 2018), *Aeolodon* (MNHN.F.CNJ 78), '*S.*' *bollensis* (SMNS 18672), '*S.*' *leedsi* (NHMUK PV R 3806), *S. edwardsi* (PETMG R178) and machimosaurins (*Lemmysuchus*: NHMUK PV R 3168; *Machimosaurus*: Hua, 1999) (although it is interesting to note that in *Sericodon*, the anterolateral tuber is well-developed but is still not nearly as pronounced as the posteromedial tuber). The genus *Mycterosuchus* (NHMUK PV R 2617), however, has an anteromedial tuber that is noticeably well pronounced and well-developed, and it is the largest of all proximal tubera (state 1).

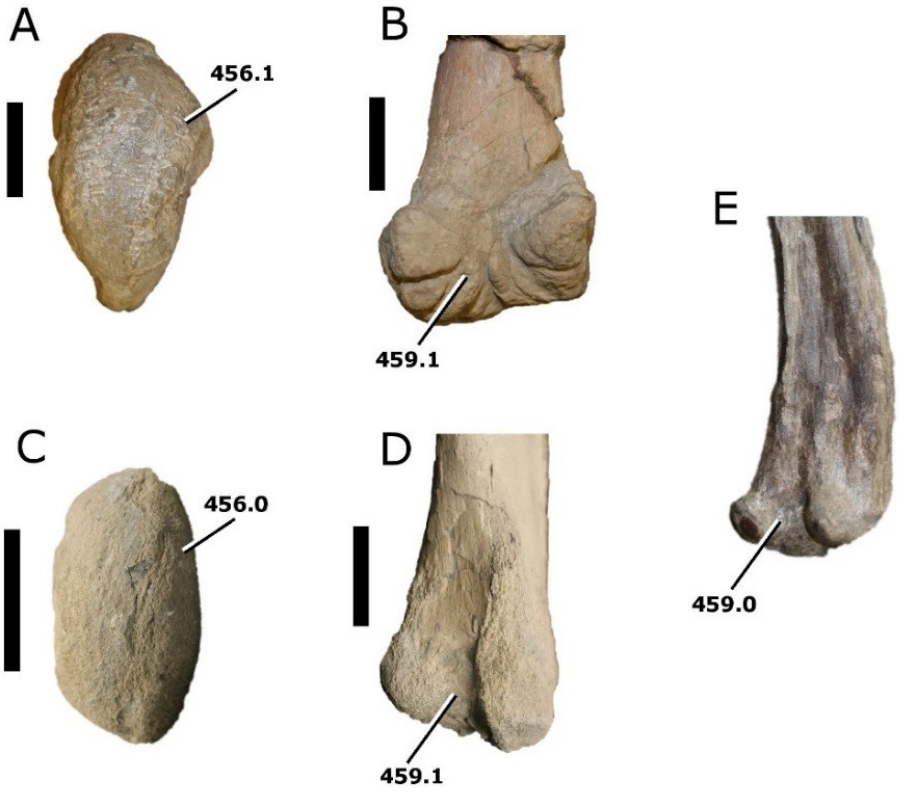


Figure 24. Comparative photographs of teleosauroid femora (ch. 456 and 459): *Mycterosuchus nasutus* (NHMUK PV R 2617) [(A) femoral head dorsal view; (B) femoral condyles posterior view], '*Steneosaurus' edwardsi* (PETMG R178) [(C) femoral head dorsal view; (D) femoral condyles posterior view] and '*Steneosaurus*' *bollensis* (SMNS 51555) ((E) femoral condyles posterior view). Scale bars: 3 cm, (E) not to scale.

459. Femur, the distal medial and lateral condyles are the same size (0), or the medial condyle is larger than the lateral condyle (1) (Fig. 24).

Another femoral feature that can differ between teleosauroids is the size of the lateral and medial condyles. These condyles are distally located, anteroposteriorly elongated, and rounded at the margins. They are separated by an intermediate groove, and the lateral condyle articulates with the proximal tibia whereas the medial condyle articulates with both the proximal tibia and fibula. The *flexor digitorum longus* (via tendon) and *flexor hallucis longus* (via fleshy attachment) muscles both originate at the lateral condyle and are responsible for extension of the knee and flexing the digits (Klinkhamer et al., 2017).

In most teleosauroids, the medial and lateral condyles of the femur are approximately the same size (state 0). This condition is seen in the basal form '*S.*' *gracilirostris* (NHMUK PV OR 14792), as well as *Platysuchus* (SMNS 9930), *Aeolodon* (MNHN.F.CNJ 78), '*S.*' *bollensis* (SMNS 51555) and *Lemmysuchus* (NHMUK PV R 3168). In certain teleosauroid genera, however, the femoral medial condyle is noticeably larger than the femoral lateral condyle (state 1). This is the case in *Mycterosuchus* (NHMUK PV R 2617) and '*S.*' *edwardsi* (NHMUK PV R 3701, PETMG R178). Note that dorsoventral crushing can distort the femoral condyles, making it appear as though the medial condyle is larger than the lateral condyle, such as in certain '*S.*' *bollensis* specimens. Johnson et al. (2017) initially described and figured this character.

464. Tibia in lateral view, the angle of tibial tuberosity is horizontal (0) or ventral (1) (Fig. 25).

The tibial tuberosity is an oblong, prominent shelf of bone on the proximal anterior area of the tibia, and is an insertion point for the tendon of the *quadriceps femoris*. In the majority of scored teleosauroids, the tibial tuberosity is horizontally placed in lateral view (state 0). This is seen in the basal form '*S.*' *gracilirostris* (NHMUK PV OR 14792) as well as *Platysuchus* (SMNS 9930), *Mycterosuchus* (NHMUK PV R 2617), *Aeolodon* (MNHN.F.CNJ 78), '*S.*' *bollensis* (SMNS 51984), '*S.*' *leedsi* (NHMUK PV R 3806) and '*S.*' *edwardsi* (NHMUK PV R 3701, PETMG R178). In select teleosauroids, the angle of the tibial tuberosity is strongly ventrally displaced. This condition (state 1) is seen in machimosaurins (*Lemmysuchus*: NHMUK PV R 3168; *Machimosaurus*: IRSNB cast; Hua, 1999).

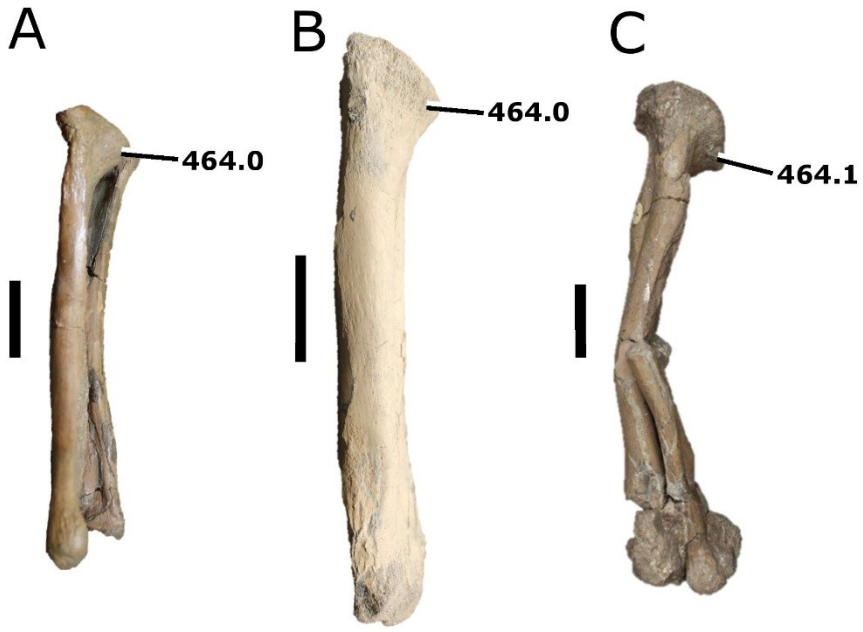


Figure 25. Comparative photographs of teleosauroid tibiaa, focusing on the tibal tuberosity (ch. 464): (A) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806), (B) '*Steneosaurus*' *edwardsi* (PETMG R178) and (C) *Lemmysuchus obtusidens* (NHMUK PV R 3168). Scale bars: 3 cm.

466. Calcaneum, the calcaneum tuber is the same size (0) or larger (1) than the astragalus (Fig. 26).

The calcaneum is the largest of the tarsal bones, representing the heel of the foot. It attaches to the distal tarsals and has a strong convex surface for articulation with the fibula (Sereno & Arcucci, 1990). In contrast, the astragalus is a roughly circular anklebone that is tightly bound to the distal ends of the tibia and fibula (Sereno & Arcucci, 1990). It is the insertion point for the *fibularis longus* muscle, which flexes the ankle (Klinkhamer et al., 2017). Both the calcaneum and astragalus are relatively the same shapes in all scored teleosauroids; both tarsal bones are also relatively the same size as one another (state 0), with the calcaneum being marginally larger. This condition is observed in *Platysuchus* (SMNS 9930), '*S.*' *bollensis* (MMG BwJ 565, SMNS 51984), '*S.*' *leedsi* (NHMUK PV R 3806), '*S.*' *edwardsi* (PETMG R178) and *Lemmysuchus* (NHMUK PV R 3168). However, in *Mycterosuchus* (NHMUK PV R 2617) the calcaneum is noticeably larger than the astragalus

(state 1), by approximately 25%. This condition is currently apomorphic for this genus.

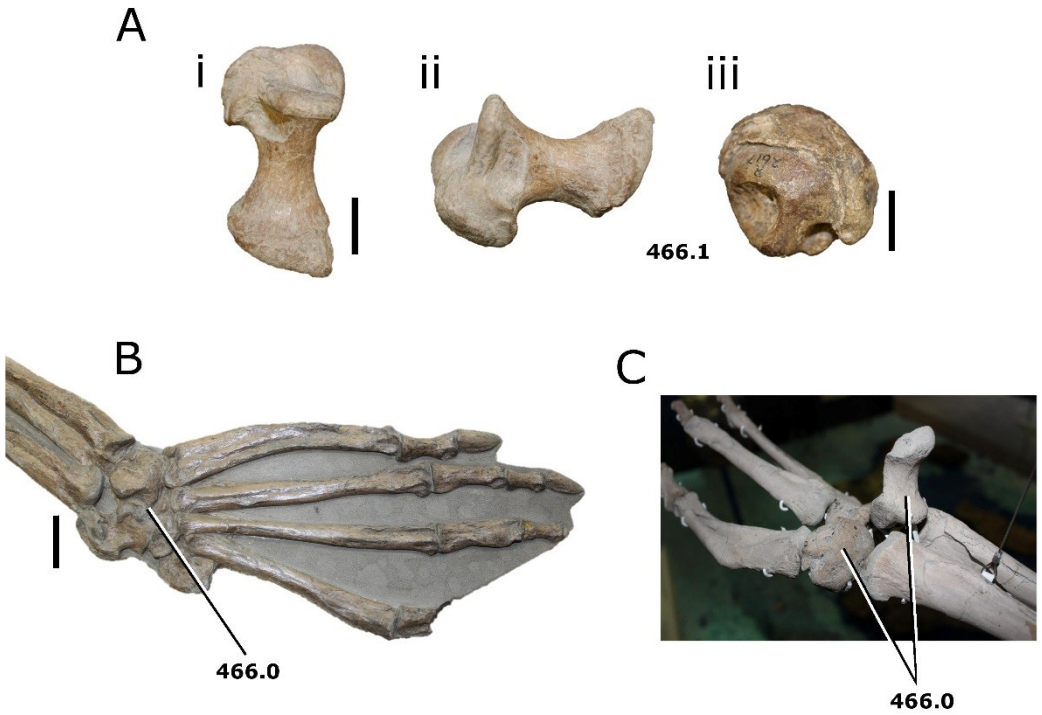


Figure 26. Comparative photographs of teleosauroid calcaneae and astragulae (ch. 466): (A) *Mycterosuchus nasutus* (NHMUK PV R 2617) [(i-ii) calcaneum in (i) dorsal and (ii) lateral view; and (iii) astragulus)], (B) '*Steneosaurus*' *bollensis* (SMNS 81699) and (C) '*Steneosaurus*' *edwardsi* (PETMG R175). Scale bars: 1.5 cm (A) and 2.5 cm (B), (C) not to scale.

489. Sacral dorsal armour (osteoderms), the dorsal keel is elongated and shallow (0), or elongated and pronounced (1) (Fig. 27).

In teleosauroids, the sacral dorsal osteoderms are often the largest, being elongated and oval in shape. In addition, there is often a longitudinal ridge (or keel) running anteroposteriorly across the near-entirety of these osteoderms, terminating at an anterior peg-like structure. In certain teleosauroids, this keel is anteroposteriorly elongated but shallow (state 0). This condition is seen in '*S.*' *gracilirostris* (NHMUK PV OR 14792), *Platysuchus* (SMNS 9930), *Teleosaurus* (NHMUK PV R 4207, NHMUK PV OR 32584), *Aeolodon* (NHMUK PV R 1086, MNHN.F.CNJ 78), '*S.*' *bollensis* (SMNS 51563) and '*S.*' *leedsi* (NHMUK PV R 3806). In more derived teleosauroids, the keel of the

sacral osteoderms is elongated, well-developed and pronounced (state 1), and is often considerably more thickened than in state 0. State 1 is well exemplified in large specimens of '*S.*' *edwardsi* (PETMG R178) as well as the machimosaurin *Lemmysuchus* (NHMUK PV R 3168). It is interesting to note that in *Mac. buffetauti* (SMNS 91415), the preserved osteoderms appear to have a shallow keel, more similar to *Platysuchus* (SMNS 9930) or *Teleosaurus* (NHMUK PV R 4207); however, it is unclear whether these osteoderms are part of the sacral dorsal shield, as they are associated with dorsal vertebrae. Therefore, *Mac. buffetauti* is currently scored as (?). This is also the case with *Mac. rex* (Fanti et al., 2016). Hua (1999) mentioned a thickened, distinct keel on the 'lumbar' osteoderms of *Mac. mosae*; the accompanying photographs are too dark to confidently determine this, though; therefore, *Mac. mosae* is also currently scored as (?).

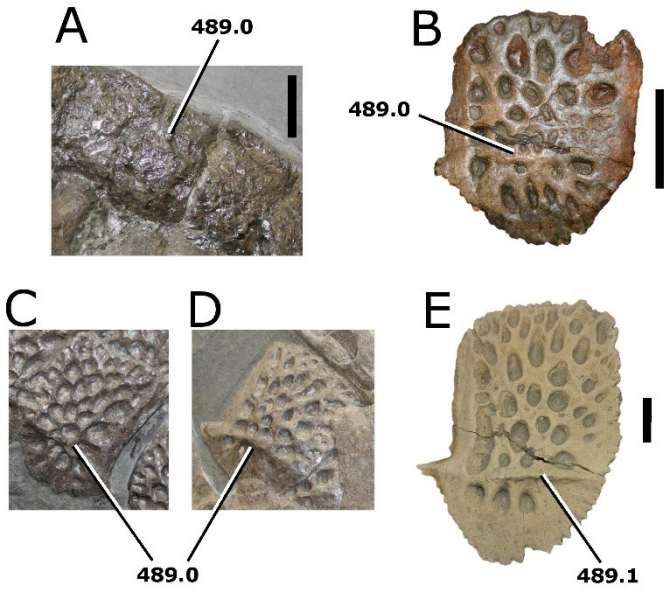


Figure 27. Comparative photographs displaying dorsal sacral osteoderms, with emphasis on the keel (ch. 489): (A) '*Steneosaurus*' *gracilirostris* (NHMUK PV OR 14892), (B) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806), '*Steneosaurus*' *bollensis* [(C) SMNS 51563; (D) SMNS 51555] and (E) '*Steneosaurus*' *edwardsi* (PETMG R178). Scale bars: 3 cm, (C) and (D) not to scale.

ADDITIONAL CHARACTER DESCRIPTIONS

In addition to the 38 new characters described above, several original characters from the 2016 H+Y dataset are key in differentiating between various teleosauroid taxa. In particular, 19 characters are anatomically distinct, variant and important in teleosauroids and are described in detail as follows:

10. Rostrum narrows markedly in dorsal view immediately in front of the orbits (0), or there is no narrowing (1) (Fig. 28).

This character is linked with character **151** (see below) and focuses on the evidence of telescopic orbits. In most teleosauroids, the posterior portion of the rostrum will either narrow slightly mediolaterally or not narrow at all, instead becoming flush with the anterior rim of the orbit (state 1). This is seen in '*S.*' *gracilirostris* (NHMUK PV OR 14792), *Mystriosaurus* (NHMUK PV OR 14781), the Chinese teleosauroid (IVPP V 10098), *Platysuchus* (SMNS 9930), and a particular subclade of teleosauroids (e.g. '*S.*' *bollensis* MMG BwJ 565; '*S.*' *leedsi*: NHMUK PV R 3806; '*S.*' *stephani*: NHMUK PV OR 49126; '*S.*' *heberti*: MNHN.F 1890-13; '*S.*' *edwardsi*: PETMG R178; *Yvridiosuchus* OUMNH J.1401, *Mac. buffetauti* SMNS 91415). In certain teleosauroids, however, there is a distinct and pronounced narrowing, or mediolateral compression, of the rostrum immediately anterior to the orbits, causing the dorsal margins of the orbits to become upturned (state 0). This condition is in *Mycterosuchus* (NHMUK PV R 2617), *Aeolodon* (MNHN.F.CNJ 78), *I. potamosiamensis* (PRC-11), *Teleosaurus* (MNHN AC 8746), *Sericodon* (Schaefer et al., 2018), and *Bathysuchus* (Foffa et al., 2019).

The skull of *Indosinosuchus* sp. (PRC-239) has been both dorsoventrally flattened and slightly anteriorly distorted. However, while there is a noticeable narrowing of the rostrum, this begins further anteriorly than in taxa with state 1 (*Mycterosuchus*; *Aeolodon*; *I. potamosiamensis*; *Teleosaurus*; *Sericodon*; and *Bathysuchus*), and there is no immediate narrowing anterior to the orbital margin (contrary to Martin et al. [2019]). The rostrum appears to be flush with the rim of the anterior orbital margin (best

seen on the left side). Therefore, this taxon was scored as state 0. Young et al. (2016) first described this character and since then it has been used in the datasets by Ristevski et al. (2018), Ősi et al. (2018), Foffa et al. (2019), Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

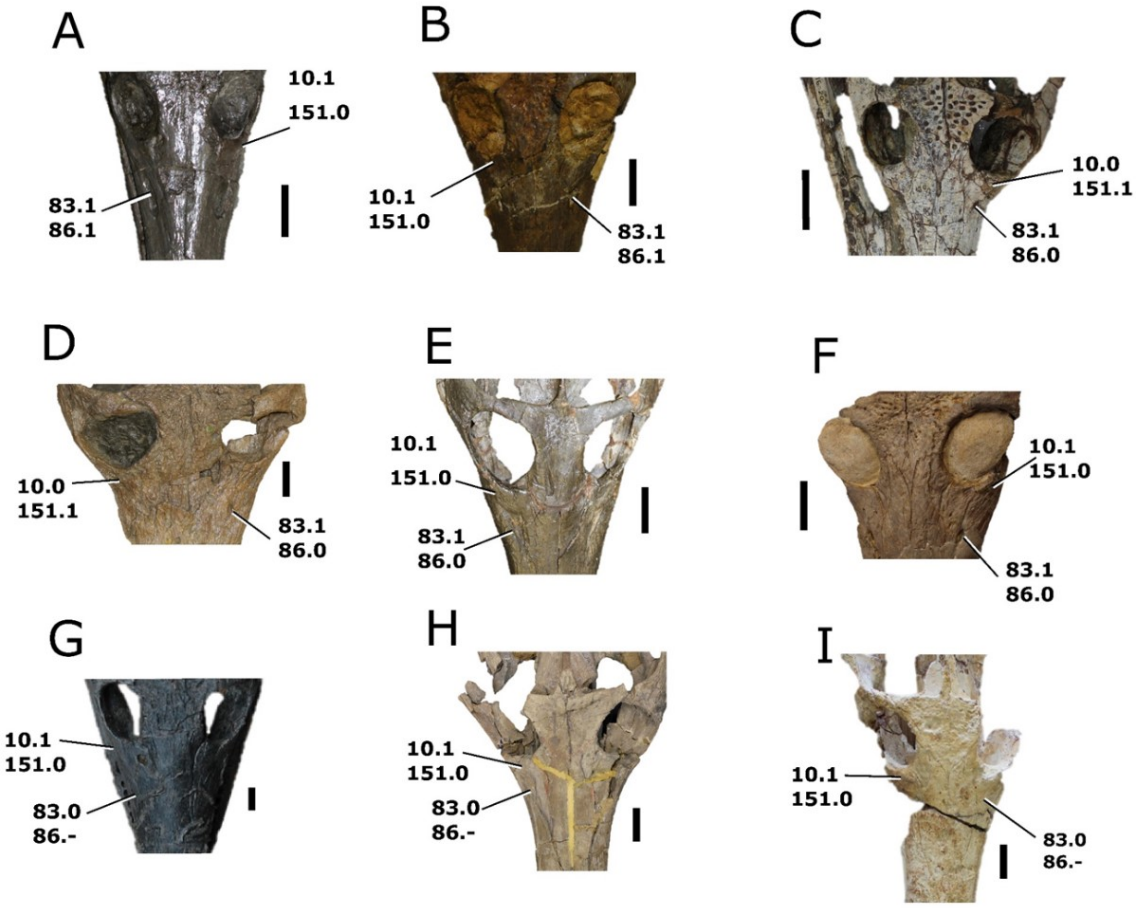


Figure 28. Comparative photographs displaying telescopic orbits (ch. 10, 151) as well as presence or absence (ch. 83) and shape of antorbital fenestrae (ch. 86) in dorsal view. (A) '*Steneosaurus*' *gracilirostris* (NHMUK PV OR 14892); (B) *Deslongchampsina larteti* (OUMNH J.29851); (C) *Indosinosuchus potamosiamensis* (PRC-11); (D) *Mycterosuchus nasutus* (NHMUK PV R 2617); (E) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806); (F) *Yvridiosuchus boutilieri* (OUMNH J.1401); (G) '*Steneosaurus*' *heberti* (MNHN.F 1890-13); (H) '*Steneosaurus*' *edwardsi* (PETMG R178); and (I) *Lemmysuchus obtusidens* (LPP.M.21). Note the shallow antorbital fenestrae of '*S.*' *leedsi* compared to other taxa with antorbital fenestrae. Scale bars: 4 cm.

27. Neurovascular foramina of the premaxillae/maxillae, either represented by a single line of small sub-circular openings (0), or two lines (one dorsal, one ventral) of large, circular openings (1) (Fig. 29).

On the lateral premaxillae and maxillae, teleosauroids possess numerous neurovascular foramina, which have allowed for the passage of blood vessels and nerves. These openings are possibly involved with multiple mechanoreceptory function such as prey detection, tactile discrimination or disruption in the surrounding water (e.g. Soares, 2002; Leitch & Catania, 2012). In most teleosauroids, the neurovascular foramina are small and subcircular in shape on both the premaxilla and maxilla, and are genrally consistent in size and number. On the premaxilla, these formania are restricted to the anteroventral and lateroventral margins of the external nares. On the ventrolateral surface of the maxilla, dorsal to the tooth row, they form a single line and are relatively well spaced. This condition (state 0) is well represented in taxa such as the basal-most teleosauroid '*S*.' *gracilirostris* (NHMUK PV OR 14792) and *Platysuchus* (SMNS 9930), *Mycterosuchus* (NHMUK PV R 2617), '*S*.' *bollensis* (PMU R161), and '*S*.' *edwardsi* (NHMUK PV 2865). *Deslongchampsina* (OUMNH J. 29851) also has restricted foramina on the premaxilla as well as a single line on the maxilla; however, the foramina are larger than those seen in other taxa with state 0, and are slightly anteroposteriorly elongated on the maxilla (most notably at the anterior and middle areas of the rostrum).

State 1 is seen in the genus *Mystriosaurus* (NHMUK PV R 14781) along with members of Machimosaurini (*Yvridiosuchus*: OUMNH J.1401, OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3168; *Mac. buffetauti*: SMNS 91415; *Mac. mosae*: Young et al., 2014a): these taxa display large, deep, numerous, sub-circular neurovascular foramina (although the foramina in *Mystriosaurus* are smaller than in machimosaurins). The premaxillary openings are generally circular in shape, located around the ventral, lateral and anteroventral margins of the external nares and cluster together (especially around the external nares' lateral margins). On the maxilla, the foramina are more anteroposteriorly elongated and situated in two parallel lines, one dorsal to the tooth row with an additional line above it (state 1). The foramina are closely spaced together at the anterior part of the maxilla, but they gradually become more distanced from one another further posteriorly. In addition, it is interesting to note that the premaxillary foramina are exceptionally large in *Yvridiosuchus* (OUMNH J.29850) as well as only

around the anteroventral margin of the external nares in *Indosinosuchus* sp. (PRC-239).

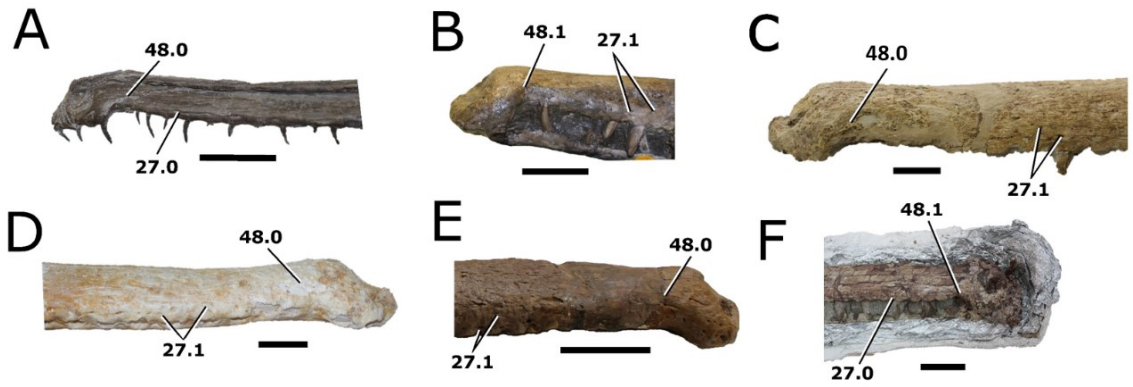


Figure 29. Comparative photographs displaying the anterior and anterolateral premaxillary margins (ch. 48) as well as neurovascular foramina (ch. 27), in lateral view: (A) '*Steneosaurus*' *bollensis* (SMNS 51563), (B) *Mystriosaurus laurillardi* (NHMUK PV OR 14781), (C) *Machimosaurus buffetauti* (SMNS 91415), (D) *Lemmysuchus obtusidens* (LPP.M.21), (E) *Yvridiosuchus boutilieri* (OUMNH J.1401) and (F) *Indosinosuchus* sp. (PRC-239). Scale bars: 5 cm.

Andrade et al. (2011) initially described this character with respect to neurovascular foramina in the taxon *Goniopholis kiplingi* (DORCM 12154). It has been subsequently updated since then by Ristevski et al. (2018), Ősi et al. (2018), Foffa et al. (2019), Johnson et al. (2019) and Sachs et al. (2019a, 2019b). I re-wrote this character to merge the absence of neurovascular foramina or presence of them as a single line into one state (state 0). This was in response to observing two parallel lines in machimosaurins (*Yvridiosuchus*: OUMNH J.1401, OUMNH J.29850; *Lemmysuchus*: LPP.M.21; *Machimosaurus*: SMNS 91415). In addition, this character may need additional re-definition, as George & Holliday (2013) recently questioned the use of facial neurovascular foramina as osteological correlates.

34. External nares oriented anteriorly or anterodorsally (0), or dorsally (1) (Fig. 30).

The orientation of the external nares is one defining feature in categorizing teleosauroids. In a certain group of predominately Laurasian teleosauroids

(see Chapter V), the external nares face either anteriorly or anterodorsally (state 0). This condition occurs in *Mystriosaurus* (NHMUK PV OR 14781), the Chinese teleosauroid (IVPP V 1009), *Mycterosuchus* (NHMUK PV R 2617), *Teleosaurus* (Eudes-Deslongchamps, 1867-69), *Platysuchus* (SMNS 9930), *Aeolodon* (MNHN.F.CNJ 78), *Sericodon* (SCR011-406 in Schaefer et al., 2018) and *Bathysuchus* (unnumbered LPP specimen). In *Mystriosaurus* (HLMD V946-948, NHMUK PV OR 14781), the external nares are oriented fully anteriorly, while in the other taxa it is oriented anterodorsally. In predominately Sub-Boreal/Gondwanan teleosauroids (see Chapter V), the external nares are oriented dorsally (state 1). This is seen in '*S*.' *bollensis* (PMU R161), '*S*.' *leedsi* (NHMUK PV R 3806), *Deslongchampsina* (OUMNH J.29851), '*S*.' *heberti* (MNHN.F 1890-13), '*S*.' *edwardsi* (NHMUK PV R 2865) and machimosaurins (*Yvridiosuchus*: OUMNH J.1401; *Lemmysuchus*: LPP.M.21; *Machimosaurus*: SMNS 91415).

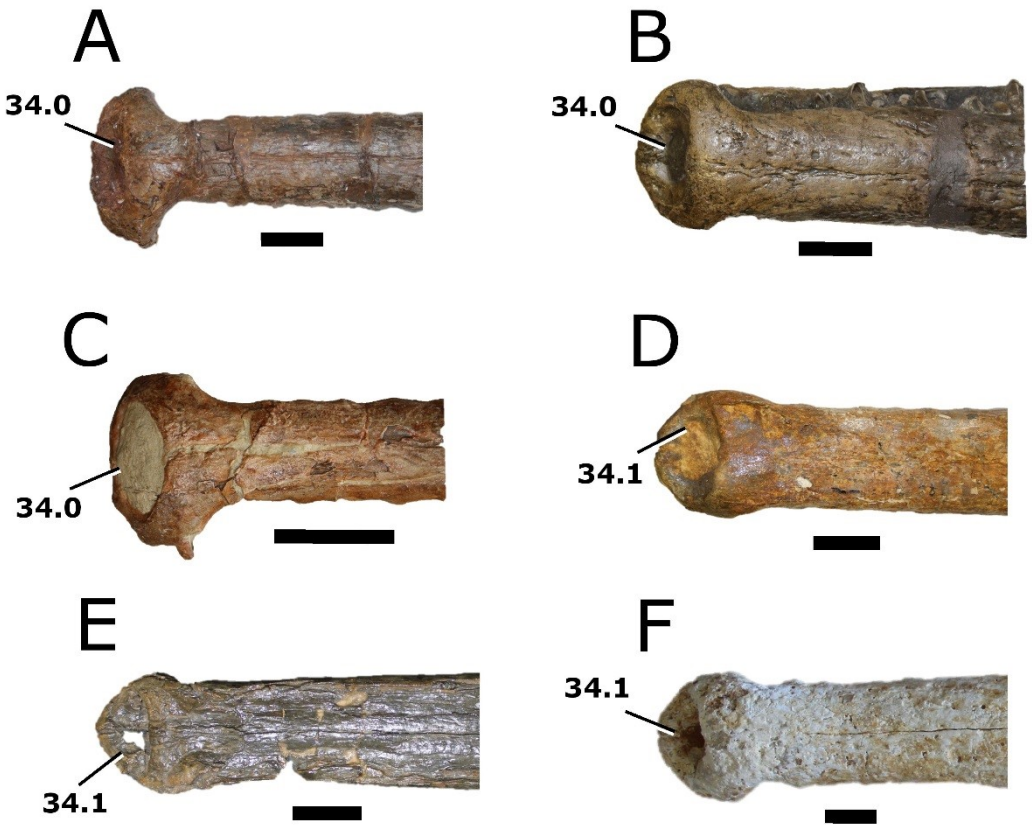


Figure 30. Comparative photographs displaying the external nares, in dorsal view (ch. 34): (A) the Chinese teleosauroid (IVPP V 10098), (B) *Mystriosaurus laurillardi* (HLMD V946-948), (C) *Bathysuchus megarhinus* (unnumbered LPP specimen), (D) *Deslongchampsina larteti* (OUMNH J.29851), (E) '*Steneosaurus*' *edwardsi* (NHMUK PV R 3701) and (F) *Lemmysuchus obtusidens* (LPP.M.21). Scale bars 3 cm.

Turner & Pritchard (2015) modified this character from Clark (1994). It has been included in the datasets of Ristevski et al. (2018), Ősi et al. (2018), Foffa et al. (2019), Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

48. Premaxilla in lateral view, the anterior and anterolateral premaxillary margins are either not sub-vertical, or do not extend ventrally (0), or the anterior and anterolateral margins are orientated anteroventrally and extend ventrally (1) (Fig. 29).

This character is important, as both states are synapomorphic in two teleosauroid families. In one subclade, the anterior and anterolateral margins of the premaxilla are not sub-vertical and do not extend ventrally (state 0) when compared to the rest of the premaxilla; rather, they are anterodorsally curved in a continuous arc throughout. This condition is seen in the basal teleosauroid '*S.*' *gracilirostris* (NHMUK PV OR 14792) as well as '*S.*' *bollensis* (PMU R161), 'S.' *leedsi* (NHMUK PV R 3806), *Deslongchampsina* (OUMNH J.29851), '*S.*' *heberti* (MNHN.F 1890-13), '*S.*' *baroni* (NHMUK PV R 1999), '*S.*' *edwardsi* (NHMUK PV R 2865) and Machimosaurini (*Yvridiosuchus*: OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3168; members of *Machimosaurus*: SMNS 91415, IRSNB cast, Young et al. [2014a]). In the second subclade, the anterior and anterolateral premaxillary margins are strongly oriented anteroventrally and extend ventrally in lateral view, giving these margins a near-vertical appearance. This condition (state 1) occurs in *Mystriosaurus* (NHMUK PV OR 14781), the Chinese teleosauroid (IVPP V 10098), *Platysuchus* (SMNS 9930), *Mycterosuchus* (NHMUK PV R 2617), *I. potamosiamensis* (PRC-11), *Bathysuchus* (unnumbered LPP specimen) and *Aeolodon* (MNHN.F.CNJ 78). It is particularly well-developed in *Mystriosaurus* (NHMUK PV OR 14781) and the Chinese teleosauroid (IVPP V 10098).

Ristevski et al. (2018) first defined and included this character in their accompanying H+Y dataset. It has since been included by Ősi et al. (2018),

Foffa et al. (2019), Johnson et al. (2019) and Sachs et al. (2019a, 2019b). However, in the current iteration of the HY datatset, this character has been heavily modified to focus on the teleosauroid anteroventral extension of the premaxilla, which is not homologous with the pholidosaurid ventral verticalisation of the premaxilla. Therefore, it is now scored as inapplicable for pholidosaurids and goniopholids.

83. Antorbital fenestrae/cavity, absent (0) or present (1) (Fig. 28).

The external antorbital fenestra is an opening situated anterior to the anterior orbital margin, and is visible in both dorsal and lateral views. It is surrounded by the maxilla and lacrimal bones, with the maxilla contributing to the ventral margin, and the lacrimal contributing to the dorsal margin. This structure is a synapomorphy of Archosauriformes (Witmer, 1997; Leardi et al., 2012), and is related to the pneumatization of the skull. Modern crocodilians have lost this feature, and in thalattosuchians, particularly metriorhynchids, the antorbital fenestra has often been associated with an exocrine gland (Leardi et al., 2012). In Teleosauroidea, this opening has been previously interpreted as homologous to the antorbital fenestra of other archosaurs (Leardi et al., 2012), and generally has very little development of the antorbital fossa (Witmer, 1997).

In most teleosauroids, a small, slit-like or subcircular antorbital fenestra is present (state 1). This condition is seen in taxa such as *Mycterosuchus* (NHMUK PV R 2617), *Indosinosuchus* (PRC-11, PRC-239), *Teleosaurus* (MNHN AC 8746), '*S*.' *leedsi* (NHMUK PV R 3806), '*S*.' *bollensis* (MMG BwJ 565) and *Yvridiosuchus* (OUMNH J.1401). The antorbital fenestrae in '*S*.' *bollensis* (MMG BwJ 565), *Teleosaurus* (MNHN AC 8746) and '*S*.' *leedsi* (NHMUK PV R 3320) are particularly shallow. In '*S*.' *gracilirostris* (NHMUK PV OR 14792) and *Deslongchampsina* (OUMNH J.29851), the antorbital fenestrae are large and elongated (see ch. **86**). However, in '*S*.' *heberti* (MNHN.F 1890-13), '*S*.' *edwardsi* (PETMG R178) and select members of Machimosaurini (*Lemmysuchus*: LPP.M.21; *Machimosaurus*: SMNS 91415; Young et al., 2014a) the antorbital fenestrae

(and internal antorbital fossae) are absent (state 0). In '*S*.' *stephani* (NHMUK PV OR 49126), it is unclear whether the antorbital fenestrae are absent or present, due to poor preservation. However, there appears to be evidence of a smooth ventral margin with a small accompanying depression in the area where the antorbital fenestrae should be located (similar to that seen in '*S*.' *leedsi*); therefore, this taxon was scored as state 1.

This character has been subsequently modified from Clark (1994) and Andrade et al. (2011), and was initially combined with an additional character in Young & Andrade (2009), Young et al. (2011a), Young et al. (2012), Young et al. (2013), Young (2014), Young et al. (2016) and Ristevski et al. (2018). It is included in its current form in the H+Y datasets from Ősi et al. (2018), Foffa et al. (2019), Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

86. Antorbital fenestrae/cavity sub-circular (0) or anteroposteriorly elongated (1) in shape (Fig. 28).

As mentioned in the previous character, most teleosauroids possess small antorbital fenestrae. In addition, with the presence or absence of these structures, the size and shape of them are also distinguishing features within teleosauroids. In the majority of taxa, the openings are subcircular or sub-oval in shape (state 0). This condition is seen in taxa including *Mystriosaurus* (NHMUK PV OR 14781), the Chinese teleosauroid (IVPP V 10098), *Indosinosuchus* (PRC-11; PRC-239), *Platysuchus* (SMNS 9930), *Teleosaurus* (MNHN AC 8746), *Mycterosuchus* (NHMUK PV R 2617), '*S*.' *bollensis* (SMNS 51555), '*S*.' *leedsi* (NHMUK PV R 3320) and *Yvridiosuchus* (OUMNH J.1401). Most notably, in '*S*.' *gracilirostris* (NHMUK PV OR 14792) and *Deslongchampsina* (OUMNH J.29851: Johnson et al., 2019), the antorbital fenestrae are large and anteroposteriorly elongated (state 1), making them appear fully oval- or teardrop-shaped. In *Deslongchampsina* (OUMNH J.29851), the antorbital fenestra is approximately 24-25% of the anteroposterior orbital length and 25% of the mediolateral orbital width; in '*S*.' *gracilirostris* (NHMUK PV OR 14792) it is approximately 57% anteroposterior orbital length and 25% of the mediolateral orbital width. The antorbital

fenestra (best seen on the right side) of *Mystriosaurus* (NHMUK PV OR 14781) is also relatively large (roughly 27% of the anteroposterior orbital length), but is not considerably elongated nor oval-shaped as in either '*S.*' *gracilirostris* or *Deslongchampsina*, and is therefore scored as state 0. Note that this character is not applicable for those taxa that lack antorbital fenestrae: '*S.*' *heberti* (MNHN.F 1890-13), '*S.*' *edwardsi* (PETMG R178), *Lemmysuchus* (LPP.M.21) and *Machimosaurus* (SMNS 91415; Young et al., 2014a). This particular character also does not score for the elongated antorbital/preorbital cavity of metriorhynchoids.

This character was modified from Young (2006) and Andrade et al. (2011). It was included in Wilkinson et al. (2008), Young & Andrade (2009), Young et al. (2011), Young et al. (2012) and Young et al. (2013). It is part of the H+Y datasets from Young et al. (2016), Ristevski et al. (2018), Ősi et al. (2018), Foffa et al. (2019), Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

102. Supratemporal fenestrae, shape is either longitudinal ellipsoid or sub-rectangular (0), square-shaped (1), transverse triangle (2), circular (3), triangle-shaped (4), or parallelogram (5) (Fig. 31).

The supratemporal fenestrae, large openings in the posterior half of the skull, are bordered by the frontal anteromedially, postorbital anterolaterally, squamosal posterolaterally and parietal posteromedially. The postorbital and squamosal contact one another along the lateral border, forming the supratemporal arch. Large supratemporal fenestrae increase the area for additional jaw adductor musculature (Johnson et al., 2017).

Teleosauroids show a variance in the shape of the supratemporal fenestrae. The majority of taxa have a sub-rectangular shaped fenestra, in which the anteroposterior axis is greater than 10% longer than the lateromedial axis (state 0). This is the condition seen in '*S.*' *gracilirostris* (NHMUK PV OR 14792; MNHNL TU515), *Platysuchus* (SMNS 9930), the Chinese teleosauroid (IVPP V 10098), *Mycterosuchus* (NHMUK PV R 2617),

Aeolodon (MNHN.F.CNJ 78), *Sericodon* (Schaefer et al., 2018), *Bathysuchus* (unnumbered LPP specimen), '*S.*' *bollensis* (MMG BwJ 565), '*S.*' *stephani* (NHMUK PV OR 49126), '*S.*' *leedsi* (NHMUK PV R 3320), '*S.*' *bouchardi* (Lepage et al., 2008), '*S.*' *heberti* (MNHN.F 1890-13) and '*S.*' *edwardsi* (NHMUK PV R 2865, PETMG R178). Two teleosauroids, *I. potamosiamensis* (PRC-11) and *Teleosaurus* (MNHN AC 8746), show state 1, which is square-shaped supratemporal fenestrae; as with state 0, the anteroposterior axis is over 10% longer than the lateromedial axis. In *Mystriosaurus* (NHMUK PV OR 14781; Sachs et al., 2019b), the openings are approximately isosceles trapezoid-shaped (roughly sub-square). In Machimosaurini (*Yvridiosuchus*: OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3168; *Mac. buffetauti*: SMNS 91415; *Mac. mosae*: IRSNB cast, Young et al., 2014a; *Mac. hugii*: NMS 7029) the supratemporal fenestrae are extremely elongated and parallelogram-shaped (state 5), with the lateral and medial margins, and anterior and posterior margins being sub-parallel. This state is a putative apomorphy within machimosaurins.

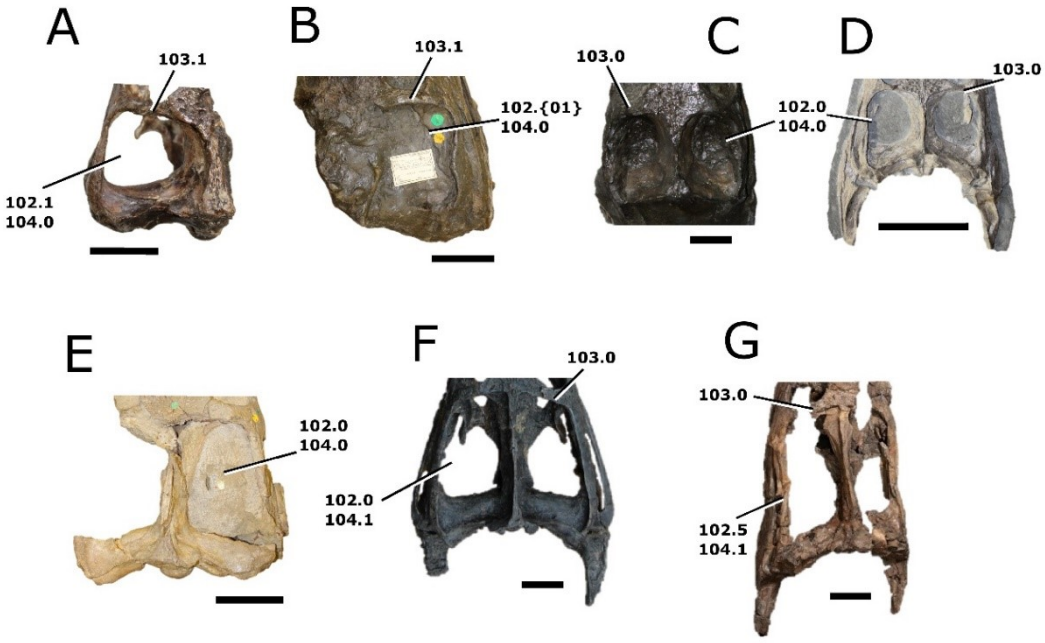


Figure 31. Comparative photographs displaying the shape of the supratemporal fenestrae (ch. 102), as well as the anterolateral expansion of the anterior portion (ch. 103) and elongation (ch. 104) of these fenestrae in dorsal view. (A) *Teleosaurus cadomensis* (MNHN AC 8746; (B) *Mystriosaurus laurillardi* (NHMUK PV OR 14781); (C) '*Steneosaurus*' *gracilirostris* (NHMUK PV OR 14892); (D) '*Steneosaurus*' *bollensis* (MMG BwJ 565); (E) '*Steneosaurus*' *stephani* (NHMUK PV OR 49126), (F) '*Steneosaurus*' *heberti* (MNHN.F 1890-13); and (G) *Lemmysuchus obtusidens* (NHMUK PV R 3168). Scale bars: 3 cm (A, C) and 10 cm (B, D-F).

This character has been heavily modified from Young & Andrade (2009), Andrade et al. (2011), Young et al. (2011), Young et al. (2012), Young et al. (2013), Young (2014) and Young et al. (2016). It was then included in the H+Y datasets from Ristevski et al. (2018), Ősi et al. (2018), Foffa et al. (2019), Johnson et al. (2019), Sachs et al. (2019a, 2019b). This character is a combination of character **111** from Andrade et al. (2011) and characters **50** to **52** from Young et al. (2016).

103. Anterior margin shape of supratemporal fenestra, no anterolateral expansion of the supratemporal fenestrae/fossae (0), or the anterior margin noticeably inclined anterolaterally (1) (Fig. 31).

The anterior margin of the supratemporal fenestra is another synapmorphic character distinguishing two main teleosauroid families. It is formed by the frontal and postorbital (the postorbital bar) anteriorly and laterally, and the frontal medially. In most teleosauroids, this margin is not anterolaterally expanded, and the anterolateral corners of the supratemporal fossae are parallel to the anteromedial corners, which makes the anterior margin of the supratemporal fenestrae appear horizontal in dorsal view (state 0). This condition is seen in the basal teleosauroid '*S.*' *gracilirostris* (NHMUK PV OR 17892) as well as one teleosauroid subclade ('*S.*' *bollensis* MMG BwJ 565; '*S.*' *stephani*: NHMUK PV OR 49126; '*S.*' *leedsi*: NHMUK PV R 3320; '*S.*' *megistorhynchus*: Eudes-Deslongchamps, 1867-69; *Deslongchampsina*: OUMNH J.29851; '*S.*' *heberti*: MNHN.F 1890-13; '*S.*' *bouchardi*: Lepage et al., 2008; '*S.*' *edwardsi*: PETMG R178; *Yvridiosuchus* OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3168; *Mac. buffetauti*: SMNS 91415; *Mac. mosae*: Hua, 1999; *Mac. hugii*: NMS 7029; *Mac. rex*: Fanti et al., 2016). However, in the second subclade, the anterolateral corners of the supratemporal fossae are noticeably inclined anteriorly than the anteromedial corners of the supratemporal fossae (state 1), giving the anterior margin an anteroposteriorly tilted appearance in dorsal view. State 1 is seen in *Mystriosaurus* (NHMUK PV OR 14781), the Chinese teleosauroid (IVPP V 10098), *Platysuchus* (SMNS 9930), *Mycterosuchus* (NHMUK PV R 2617), *Indosinosuchus* (PRC-11, PRC-239) and *Aeolodon* (MNHN.F.CNJ 78). This

'tilted' anterior margin of the supratemporal fenestra is well displayed in *Mystriosaurus* (NHMUK PV OR 14781).

Ristevski et al. (2018) first included this character the H+Y dataset, and is in updated versions by Ősi et al. (2018), Foffa et al. (2019) Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

104. Supratemporal fenestrae, overall anteroposterior elongation is either less than or sub-equal to the anterior width (0), or is twice as long as the anterior width, or more (1) (Fig. 31).

This character is related in part to ch. **102**, specifically in regards to the parallelogram-shaped supratemporal fenestrae see in Machimosaurini. It examines the overall anteroposterior elongation of the supratemporal fenestra and how the mediolateral width relates to total length. It is important to note that this character is not homologous to the anteroposterior elongation of the supratemporal fenestrae in other clades, as the extreme anteroposterior elongation of the proötics, laterosphenoids, postorbital posterior processes, parietal anterior process and frontal posterior process causes it. In most teleosauroids, the anteroposterior length of the supratemporal fenestrae is approximately the same as the width (state 0). This condition is in the basal-most form '*S.*' *gracilirostris* (NHMUK PV OR 14792) as well as *Mystriosaurus* (NHMUK PV OR 14781), *Indosinosuchus* (PRC-11; PRC-239), *Platysuchus* (SMNS 9930), *Teleosaurus* (MNHN AC 8746), *Mycterosuchus* (NHMUK PV R 2617), *Bathysuchus* (unnumbered LPP specimen), *Aeolodon* (MNHN.F.CNJ 78), '*S.*' *bollensis* (MMG BwJ 565), '*S.*' *stephani* (NHMUK PV OR 49126), '*S.*' *leedsi* (NHMUK PV R 3806) and *Deslongchampsina* (OUMNH J.29851). In more derived teleosauroids, the anteroposterior width of the supratemporal fenestrae are approximately twice as long as the width (state 1). This condition is in '*S.*' *heberti* (MNHN.F 1890-13), '*S.*' *bouchardi* (Lepage et al., 2008), '*S.*' *edwardsi* (PETMG R178) and machimosaurins (*Yvridiosuchus*: OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3168; *Machimosaurus*: SMNS 91415, IRSNB cast, Young et al.

[2014a]). In the genus *Machimosaurus*, the width of the supratemporal fenestrae increases but the extreme elongation of the bones is still present.

Ristevski et al. (2018) first included this character in the corresponding HY dataset, with the focus being on goniopholids. It has since then been used in Ősi et al. (2018), Foffa et al. (2019), Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

151. The circumorbital dorsal margins of the orbits are flush with the skull dorsal surface (0), upturned (prominent along the orbital medial margin in dorsal view, with the frontal interorbital margins being upturned) (1), or upturned along with the posterior margins (the frontal lateral process anterior margins are also upturned) (2) (Fig. 28).

This character is linked with character **10** (see above) and focuses on the evidence of telescopic orbits. In taxa with enlarged, protruding eyes, the dorsal margin of the orbit (which includes the prefrontal and the lacrimal) is abruptly dorsally oriented. This creates a slight ridge along this margin. In the majority of teleosauroids, the orbital dorsal margins are flush (=flattened) with the skull dorsal surface (state 0), and display no evidence of any dorsal upturn. This condition is seen in the basal teleosauroid '*S*.' *gracilirostris* (NHMUK PV OR 14792) as well as *Mystriosaurus* (NHMUK PV OR 14781), the Chinese teleosauroid (IVPP V 10098), *Indosinosuchus* sp. (PRC-239), *Platysuchus* (SMNS 9930), '*S*.' *bollensis* (MMG BwJ 565), '*S*.' *stephani* (NHMUK PV OR 49126), '*S*.' *leedsi* (NHMUK PV R 3320), *Deslongchampsina* (OUMNH J.29851), '*S*.' *heberti* (MNHN.F 1890-13), '*S*.' *edwardsi* (NHMUK PV R 2865) and Machimosaurini (*Yvridiosuchus*: OUMNH J.1401; *Lemmysuchus*: LPP.M.21; *Mac. buffetauti*: SMNS 91415; *Mac. mosae*: Hua, 1999; *Mac. hugii*: Young et al., 2014a).

Four teleosauroid taxa (*I. potamosiamensis*: PRC-11; *Mycterosuchus*: NHMUK PV R 2617; *Teleosaurus*: MNHN AC 8746; *Aeolodon*: MNHN.F.CNJ 78) have a definitive upturning of the orbital dorsal margin (state 1), contributing to the protruding appearance of the orbits. This condition may

also be present in *Bathysuchus*; however, the only available skull (unnumbered LPP specimen) is severely anteroventrally distorted in the orbital areas (note that it appears intact in dorsal view, but in lateral view, it is evident of this disconfiguration). Due to incomplete material and poor preservation, this taxon is currently scored as (?). This character was initially modified from Brochu (1999) and Salas-Gismondi et al. (2016), and was included in Ősi et al. (2018), Foffa et al. (2019), Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

158. Orbit, the postorbital is excluded from the orbit posteroventral margin or only present in the posteroventral margin (0), or the postorbital reaches the orbit posteroventral margin and extensively forms part of the orbit ventral margin (1) (Fig. 32).

The postorbital is the bone situated directly behind the orbits, forming the immediate posterior orbital margin as well as the lateral and posteroventral borders of the supratemporal fenestra. In most teleosauroids, the postorbital does not contact the posteroventral margin of the orbit (state 0). This is the condition seen in the basal-most teleosauroid (‘*S.*’ *gracilirostris*: MNHNL TU515, NHMUK PV OR 14792) as well as more derived taxa (e.g. ‘*S.*’ *leedsi*: NHMUK PV R 3806; *Deslongchampsina*: OUMNH J.29851; ‘*S.*’ *heberti*: MNHN.F 1890-13; ‘*S.*’ *edwardsi*: NHMUK PV R 2865, PETMG R178; *Yvridiosuchus*: OUMNH J.29850; *Mac. mosae*: IRSNB cast). However, in specific teleosauroid taxa, the postorbital contacts the posteroventral margin of the orbit, forming a substantial proportion of the orbital ventral margin. Due to this extension, the postorbital often overlaps the posterior part of the jugal. This condition (state 1) is found in basal teleosauroids (*Mystriosaurus*: NHMUK PV OR 14781; the Chinese teleosauroid: IVPP V 10098; *I. potamosiamensis*: PRC-11; *Platysuchus*: SMNS 9930; *Teleosaurus*: MNHN AC 8746; *Mycterosuchus*: CAMSM J.1420).

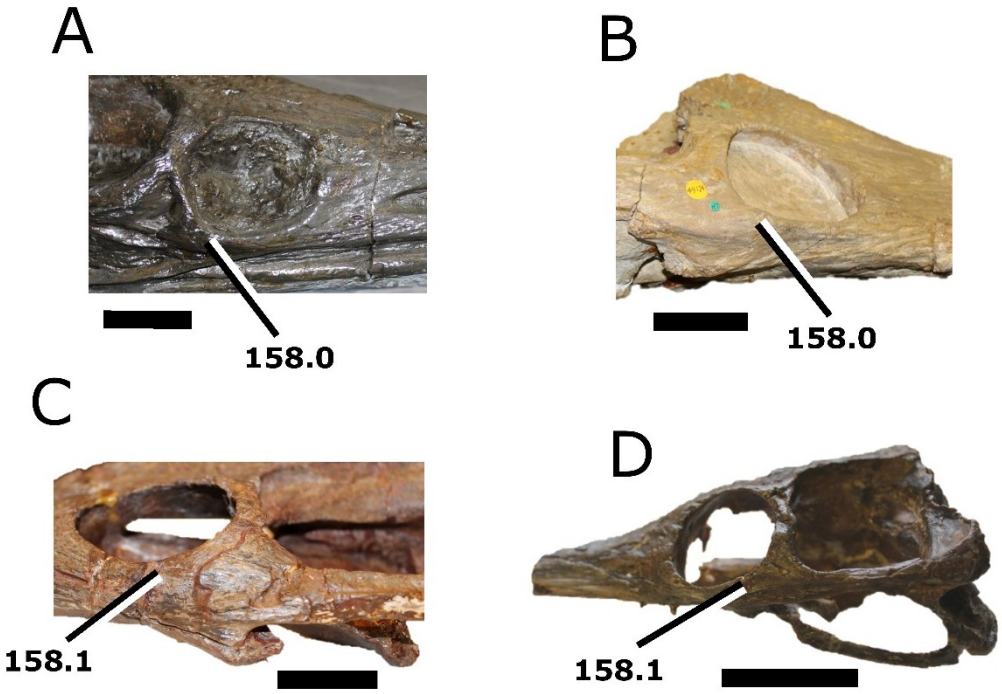


Figure 32. Comparative photographs of teleosauroid orbital margin (in lateral view), focusing on the inclusion of the postorbital (ch. 158): (A) '*Steneosaurus*' *gracilirostris* (NHMUK PV OR 14892), (B) '*Steneosaurus*' *stephani* (NHMUK PV OR 49126), (C) the Chinese teleosauroid (IVPP V 10098) and (D) *Teleosaurus cadomensis* (MNHN AC 8746). Scale bars: 3 cm.

It is important to note that some dorsoventrally crushed skulls appear as if they have state 1 (e.g. certain specimens of '*S.*' *bollensis*). This character was initially written with another character in Young & Andrade (2009), Young et al. (2011a) and Young et al. (2013). It has been included in Young et al. (2012) and Young (2014), and in the H+Y datasets from Young et al. (2016), Ristevski et al. (2018), Ősi et al. (2018), Foffa et al. (2019) Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

225. Basisphenoid, exposure anterior to the quadrates in palatal view: absent or basisphenoid terminates approximately level to the anterior extent of the quadrates (0), or basisphenoid 'rostrum' (=cultriform process) is exposed along the palatal surface anterior to the quadrates and continues to bifurcate the pterygoids (1) (Fig. 33).

The basisphenoid is a bone of the posterior cranium that forms the floor of the braincase, anterior to the basioccipital. It contacts the basioccipital

ventrally, the laterosphenoid dorsally and the quadrate anteromedially. The posterior basisphenoid is broad, and the anterior basisphenoid is elongated and narrow (Brusatte et al., 2016). There are two elongated anteroposteriorly- and posterolaterally-directed processes (=prongs) that can also be seen in occipital view.

In certain teleosauroids, when examining the anterior exposure of the basisphenoid in palatal view, this bone terminates approximately at the level of the anterior-most quadrates (state 0). This is the condition seen in *I. potamosiamensis* (PRC-11) and *Mycterosuchus* (CAMSM J.1420). In addition, it is important to note that this morphology is absent in both *Teleosaurus* (MNHN AC 8746) and the Chinese teleosauroid (IVPP V 10098) (also scored as state 0). In the majority of teleosauroids, the basisphenoid is well exposed along the palatal surface anterior to the quadrates and bifurcates the pterygoids (state 1), which is caused by the posterior expansion of the posterior margin of the pterygoid; the anterior part of the quadrates, and the lateral margins of the basisphenoid, are obscured. However, a distinct basisphenoid 'rostrum' is present that continues to separate the pterygoids anteriorly. State 1 is a putative apomorphy of one teleosauroid subclade and is seen in '*S*.' *bollensis* (SMNS 81699), '*S*.' *stephani* (NHMUK PV OR 49126), '*S*.' *leedsi* (NHMUK PV R 3320), *Deslongchampsina* (OUMNH J.29851), '*S*.' *heberti* (MNHN.F 1890-13), '*S*.' *edwardsi* (NHMUK PV R 2865), *Yvridiosuchus* (OUMNH J.403) and *Lemmysuchus* (LPP.M.21). State 1 also appears to be present in '*S*.' *stephani* (NHMUK PV OR 49126), but the anterior basisphenoid is poorly preserved; this taxon is therefore currently scored as (?). In addition, it is not

present in the basal metriorhynchoid *Pelagosaurus* or members of Metriorhnchidae.

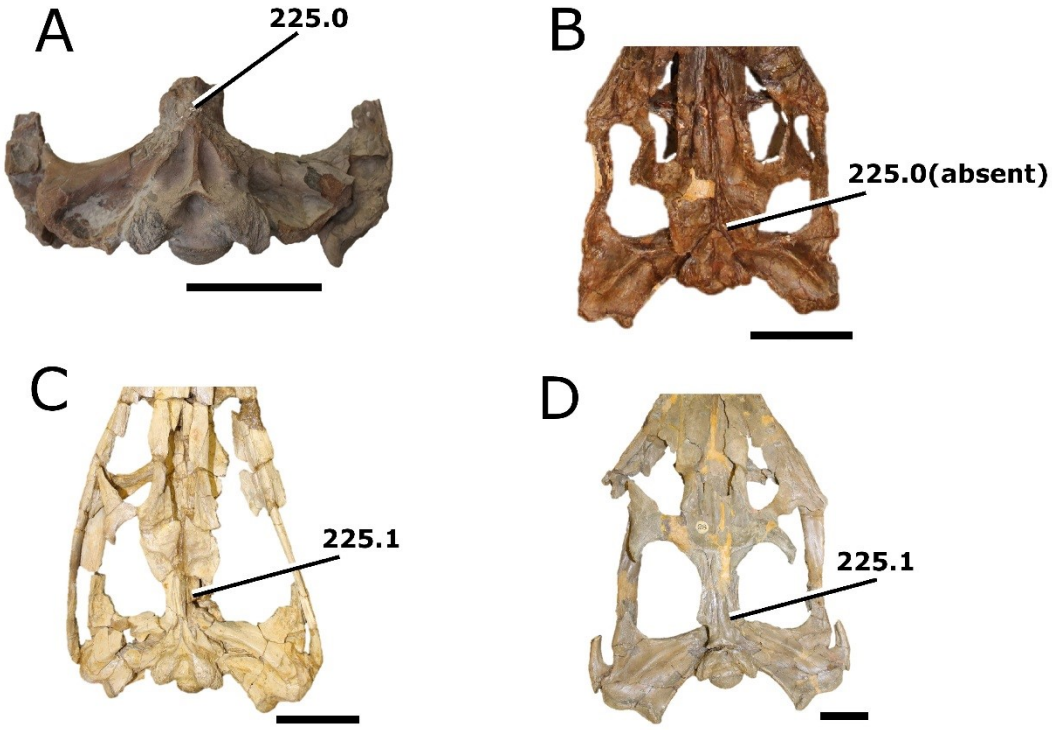


Figure 33. Comparative photographs exhibiting exposure of the teleosauroid basioccipital (ch. 225): (A) *Mycterosuchus nasutus* (CAMSM J.1420), (B) the Chinese teleosauroid (IVPP V 10098), (C) '*Steneosaurus*' *leedsi* (NHMUK PV R 3320) and (D) '*Steneosaurus*' *edwardsi* (NHMUK PV R 2865). Scale bars: 7 cm.

Wilkinson et al. (2008) first included this character in a phylogenetic matrix, which was later modified in Young & Andrade (2009) and Young et al. (2011). The current written character is found in Young et al. (2012), Young et al. (2013), Young (2014) and Young et al. (2016), and within the H+Y datasets from Ristevski et al. (2018), Ősi et al. (2018), Foffa et al. (2019) Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

327. Dentition along the entirety of the tooth row, with sharp, pointed apices (0) or blunt, round apices (1) (Fig. 16).

In the majority of teleosauroids, the teeth are slender and sharp, with pointed apices (state 0). This condition can clearly be seen in the basal-most form '*S.*' *gracilirostris* (MNHNL TU515) as well as in most teleosauroids (e.g.

Indosinosuchus sp.: PRC-238, PRC-239; *Platysuchus*: SMNS 9930; *Mycterosuchus*: NHMUK PV R 2617; *Bathysuchus*: DORCM G.05067iv; *Sericodon* (TCH005-151 in Schaefer et al., 2018), '*S.*' *bollensis*: MNHNL TU799; '*S.*' *leedsi*: NHMUK PV 3806; '*S.*' *megistorhynchus*: OUMNH J.1414). While the taxa *Mystriosaurus* (HLMD V946-948, NHMUK PV OR 14781), '*S.*' *heberti* (MNHN.F 1890-13), *Deslongchampsina* (OUMNH J.29851) and '*S.*' *edwardsi* (PETMG R178) possess teeth with pointed apices (and are therefore scored as state 0), it is important to note that the overall dentition of these four genera are more robust than in the other aforementioned teleosauroids. In particular, the posterior teeth of '*S.*' *edwardsi* (PETMG R178) are noticeably more conical, but continue to retain a pointed apex. The tribe Machimosaurini (Jouve et al., 2016) is unique in that all members (*Yvridiosuchus*: OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3618; *Machimosaurus*: LMH 16387, LMH 16405, MG-8730-1, ONM NG 7, SMF 2027, SMNS 91415) have conical teeth with blunt, rounded apices (state 1).

von Meyer (1837) initially noted the rounded apices of the conical teeth in *Mac. hugii*, and since then this character has become a staple of machimosaurin dental morphology. Young et al. (2011a) first included this character into a phylogenetic matrix, and it has been subsequently included in the following HY datasets: Young et al. (2016); Ristevski et al. (2018); Ősi et al. (2018); Foffa et al. (2019) Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

358. Morphology of apical enamel surface ornamentation, macroscopic anastomosed pattern absent (0) or present (1) (Fig. 16).

As with the above character, the apices of the teeth are relatively smooth and unornamented, aside from the enamel ridges that reach the tip of the apex (state 0) in most teleosauroids. This is the condition seen in '*S.*' *gracilirostris* (MNHNL TU515), as well as *Mystriosaurus* (NHMUK PV OR 14781); *Indosinosuchus* sp. (PRC-239); *Platysuchus* (SMNS 9930); *Teleosaurus* (Eudes-Deslongchamps, 1867-69); *Mycterosuchus* (NHMUK PV R 2617); *Bathysuchus* (DORCM G.05067iv); *Sericodon* (TCH005-151 in Schaefer et

al., 2018); *Aeolodon* (NHMUK PV R 1086); '*S.*' *bollensis* (MNHNL TU799); '*S.*' *leedsi* (NHMUK PV R 3806); '*S.*' *megistorhynchus* (OUMNH J.1414); *Deslongchampsina* (OUMNH J.29851); '*S.*' *heberti* (MNHN.F 1890-13); and '*S.*' *edwardsi* (NHMUK PV R 3701; PETMG R178). However, the tribe Machimosaurini evolved a complex ornamentation pattern (state 1), in addition to other features of the dentition (see above) in response to a shift in diet and craniomandibular changes. This pattern is often referred to as 'anastomosed', which is described in zoological terms as the joining of structures to form a branching network. In machimosaurin teeth, this is shown as the branching and criss-crossing of enamel ridges: this translates into a rough, 'wrinkled' texture, visible to the naked eye, on the apical third of the tooth. Anastomosed teeth are one of the characteristic features in machimosaurins, and is present in all members of the group (*Yvridiosuchus*: OUMNH J.29850; *Lemmysuchus*: NHMUK PV R 3168; *Machimosaurus*: SMNS 91415, MG-8730-1, ONM NG 7, SMF 2027). This type of anastomosed pattern also appears in the geosaurin *Torvoneustes*, and select members of Goniopholididae (e.g. *Anteophthalmosuchus* and *Goniopholis*).

Young et al. (2012) first described this character and included it in a phylogenetic dataset. It has since then been included in Young (2014) as well as the H+Y versions found in Young et al. (2016), Ristevski et al. (2018), Ősi et al. (2018), Foffa et al. (2019), Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

379. Number of sacral vertebrae is two (0) or three (1) (Fig. 19).

In the majority of teleosauroids, there are two sacral vertebrae present (state 0). This condition is seen in the basal form '*S.*' *gracilirostris* (NHMUK PV OR 14792) as well as *Platysuchus* (SMNS 9930), *Teleosaurus* (NHMUK PV OR 32588), *Mycterosuchus* (NHMUK PV R 2617), *Aeolodon* (MNHN.F.CNJ 78), '*S.*' *bollensis* (SMNS 52034), '*S.*' *leedsi* (NHMK PV R 3806), and '*S.*' *edwardsi* (NHMUK PV R 3701, PETMG R178). However, in members of Machimosaurini (*Lemmysuchus*: NHMUK PV R 3618; *Mac. mosae*: IRSNB cast, Hua, 1999), three sacral vertebrae are present, which is a unique

feature of this clade. The first two vertebrae are true sacrals, with the first caudal vertebra appearing and functioning as a third sacral. This 'pseudo-sacral' has large, mediolaterally expanding transverse processes as well as an expanded lateral iliac attachment area, similar to the two primary sacrals.

Buscalioni & Sanz (1988) initially reported the presence of more than two lumbar (sacral) vertebrae in atoposaurids. Pol & Apesteguia (2005) reported the fusion of sacral two plus the first caudal vertebra for *Notosuchus*. Andrade et al. (2011) mentioned that the number of sacral vertebrae is increased by adding the last dorsal/lumbar or the first caudal, and that the fusion found in *Notosuchus* differs from that in *Alligatorellus* and *Montsecosuchus* (fusion of the first and second sacrals). Specifically, for teleosauroids, this character was first noted in detail by Andrews (1913) when describing *Lemmysuchus* (then known as '*Steneosaurus*' *obtusidens*). Since then, the three sacrals have been described and figured by Young et al. (2014a) and Johnson et al. (2017), and have been included in the datasets by Andrade et al. (2011);, Ristevski et al. (2018), Ősi et al. (2018), Foffa et al. (2019), Johnson et al. (2019) and Sacs et al. (2019; in press).

410. Humerus, proximal region: confined to the proximal surface (0), posteriorly expanded and hooked (1), or very strongly posteriorly deflected and hooked (2) (Fig. 34).

In scored teleosauroids, the proximal area of the humerus is either posteriorly expanded and hooked (state 1) or strongly deflected and hooked (state 2); it is never confined to the proximal surface (state 0). In basal teleosauroids such as '*S*.' *gracilirostris* (NHMUK PV OR 14792), *Platysuchus* (SMNS 9930), *Teleosaurus* (OUMNH J.26801), '*S*.' *bollensis* (SMNS 51957) and *Mycterosuchus* (NHMUK PV R 2617), the proximal humerus (or humeral head) is anteroposteriorly elongated and gently hooked (state 1). Of the aforementioned taxa, the humeral head of '*S*.' *bollensis* (SMNS 51563) is the most elongated and somewhat rod-like, with a very slight hook. While currently scored as state 1, the humerus of *Mycterosuchus* (NHMUK PV R 2617) is odd: while still hooked, it is noticeably less so than in other

teleosauroids (e.g. '*S.*' *leedsi*: NHMUK PV R 3806; '*S.*' *edwardsi*: PETMG R178), with the proximal end being more circular, proximally oriented and 'club'-like. However, it is important to consider that this feature may be due to dorsoventral crushing, as many OCF taxa are prone to this type of preservation. In more derived teleosauroids such as *Aeolodon* (MNHN.F.CNJ 78), '*S.*' *leedsi* (NHMUK P R 3806) and '*S.*' *edwardsi* (PETMG R178), the posterior deflection of the proximal humerus is strong, so much so that the proximal epiphysis noticeably posterior to the distal epiphysis. This posterior deflection is much more pronounced than in another other thalattosuchians.

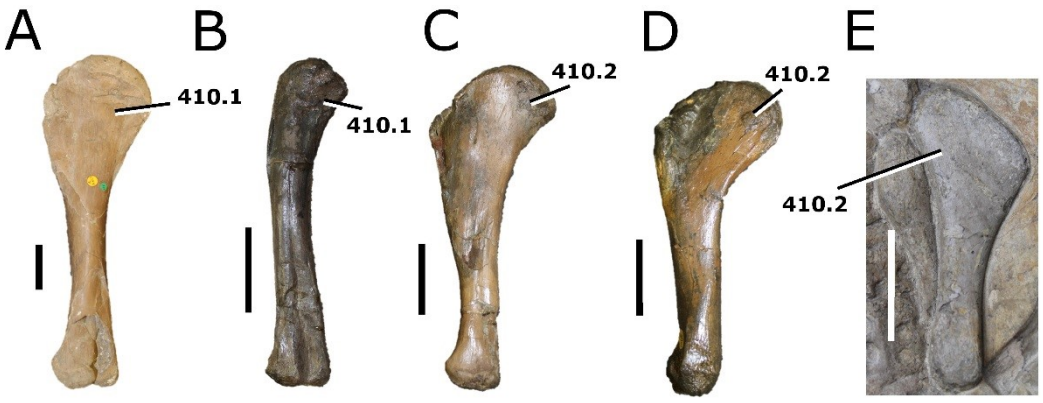


Figure 34. Comparative photographs of teleosauroid humeri (ch. 410): (A) *Mycterosuchus nasutus* (NHMUK PV R 2617), (B) '*Steneosaurus*' *bollensis* (SMNS 18672), (C) '*Steneosaurus*' *edwardsi* (NHMUK PV R 3701), (D) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806) and (E) *Aeolodon priscus* (MNHN.F.CNJ 78). Scale bars: 3 cm.

This character was initially modified from Nesbitt (2011), and again in Young et al. (2012). Young et al. (2016) included the addition of state 2. This updated version has been used in Ristevski et al. (2018), Ősi et al. (2018), Foffa et al. (2019) Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

420. Ulna, olecranon process mediolaterally compressed and greatly proximally expanded: no (0), yes (1) (Fig. 20).

The olecranon process (the expanded concavity of the proximal ulna) forms the elbow of the forelimb and articulates with the proximal head of the radius. It is an insertion point for the *triceps longus lateralis*, *triceps longus medialis* and *anconeus humeralis lateralis* (all involved with elbow extension)

(Klinkhamer et al., 2017). Creating a very broad olecranon process allows for greater surface area for muscle attachment. Only two basal teleosauroids (*Platysuchus*: SMNS 9930; '*S.*' *bollensis* SMNS 53422) score as 0, in which the olecranon process is neither compressed nor expanded. Interestingly, more derived teleosauroids score as state 1, where the olecranon process is both greatly expanded and mediolaterally compressed. This is seen in *Mycterosuchus* (NHMUK PV R 2617), *Aeolodon* (MNHN.F.CNJ 78), '*S.*' *leedsi* (NHMUK PV R 3806), '*S.*' *edwardsi* (PETMG R178) and *Lemmysuchus* (NHMUK PV R 3168). Ősi et al. (2018) first defined this character, and it is present in the following datasets (Foffa et al., 2019; Johnson et al., 2019; Sachs et al., 2019a, 2019b).

440. Ilium, postacetabular (= posterior) process expanded into a thin 'fan' shape: no (0), yes (1) (Fig. 22).

In most teleosauroids, the postacetabular (=posterior) iliac process, which is situated posteriorly on the dorsal margin of the ilium, is either anteroposteriorly shortened, robust and process-like (state 0) or anteroposteriorly expanded and mediolaterally thin, expanding it into a "fan-like" shape (state 1), and is best seen in either lateral or medial view. In '*S.*' *leedsi* (NHMUK PV R 3806), '*S.*' *edwardsi* (PETMG R178), *Lemmysuchus* (NHMUK PV R 3816) and *Mac. mosae* (Young et al., 2014a), state 1 is exhibited, with the postacetabular process lengthened into a mediolaterally thin 'fan-like' shape. However, it is important to note that state 1 is a putative apomorphy of derived teleosauroids, and is not seen in basal taxa such as '*S.*' *gracilirostris* (NHMUK PV OR 14792), *Platysuchus* (SMNS 9930), *Teleosaurus* (NHMUK PV OR 32588), *Sericodon* (SCR010-312 in Schaefer et al., 2018) and '*S.*' *bollensis* (SMNS 18672, SMNS 51753). This structure is a modification of the postacetabular (=posterior) process in these taxa. However, I believe that it is important to highlight and figure this difference.

Young et al. (2012) first highlighted this character, and was subsequently found in Young (2014), Wilberg (2015b), Young et al. (2016),

Ristevski et al. (2018), Ősi et al. (2018), Foffa et al. (2019) Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

473. Ornamentation (dorsal osteoderms), the pits are either small round to ellipsoid and very densely distributed (0), large round to ellipsoid and well separated (1), irregularly shaped with an extreme variation in size, with elongate pits present on the ventrolateral surface running from the keel to the lateral margin (2), or variable in both size, shape and length that radiate in a starburt pattern (3) (Fig. 35).

Osteoderms are bony deposits that form scales, plates, or other structures within the skin. These dorsal structures are highly developed and are arranged in dorsal longitudinal rows (Seidel, 1979), and display a delay in development when compared to the rest of the skeleton (Vickaryous & Hall, 2008). In extant crocodilians, the pitting ornamentation of dorsal osteoderms are vascularized (Seidel, 1979; Grigg & Seebacher, 2001; Young et al., 2014a), and may play a role with regards to thermoregulation or basking behaviours (Young et al., 2014a). In teleosauroids, and other fossil crocodylomorph groups, two parallel rows of mediolaterally elongate osteoderms contribute to the paramedian shield (Johnson et al., 2018). The shape of the osteoderms differs in specific areas of the body (Andrews, 1913). Cervical ones are small and generally box- or square-shaped, with a very faint or absent keel and no anterolateral process. The thoracic/sacral dorsal osteoderms (which are typically the largest, especially in the sacral area) are anteroposteriorly elongated and either oval or rectangular. Generally, a pronounced, anteroposteriorly directed keel runs the length of the osteoderm, and the anterolateral process is well-developed. In the caudal area, the osteoderms start as similar to the sacral ones, but become progressively smaller and more subcircular in shape, and the keel disappears in the posterior-most caudal ones. In the more posteriorly placed caudal osteoderms, the anterolateral process takes up the entirety of the anterior margin. The dorsal area of all osteoderms are convex and covered with pits, while the ventral area is smooth, slightly concave and unaltered.

While the overall shape of the dorsal osteoderms is consistent in certain areas of the body across taxa, the ornamentation (or pitting) pattern differs, most notably in the thoracic/sacral osteoderms. In most teleosauroids, the pits are large, subcircular to ellipsoid in shape, and generally well separated from one another. This condition (state 1) is seen in '*S*.' *gracilirostris* (NHMUK PV OR 14792), *Mycterosuchus* (NHMUK PV R 2617), '*S*.' *leedsi* (NHMUK PV R 3806) and '*S*.' *edwardsi* (NHMUK PV R 2865; NHMUK PV R 3701; PETMG R178). In '*S*.' *leedsi* (NHMUK PV R 3806), the pits are arranged in a semi-circular pattern, and the larger ones are situated more towards the lateral margins of the osteoderm. In '*S*.' *edwardsi* (NHMUK PV R 2865), most pits are exceptionally large (especially situated in the centre of the osteoderm), subcircular and fewer in number. While the osteoderm ornamentation in the holotype of '*S*.' *bollensis* (MMG BwJ 595) is poorly preserved, the pits appear to be large and semi-ellipsoid with a strong anteroposterior keel. The pits also appear to be more closely placed to one another, which is observed in other '*S*.' *bollensis* specimens (e.g. MMG BwJ 565; SMNS 51563; SMNS 51753), with a thin ridge separating them. In two teleosauroid taxa, the ornamental pits are small, round, and extremely densely distributed throughout the entirety of the dorsal osteoderms (state 0). This is seen in *Platysuchus* (SMNS 9930) and *Teleosaurus* (NHMUK PV R 119a). Some teleosauroids, however, possess thoracic/sacral osteoderms with exceptionally enlarged, elongated pits; due to this elongation and large size, these pits merge with one another and become elongated grooves, especially along the lateral margins, with the pits radiating distally in a 'starburst' pattern (state 3). The remainder of the pits are variable in size (from small to large), irregularly shaped, and relatively close together. In addition, well-developed keels are generally present in these osteoderms. This condition is observed in machimosaurins (*Lemmysuchus*: NHMUK PV R 3618; *Machimosaurus*: ONM 1-25, SMNS 91415, Young et al., 2014a). State

2, in which the pits are all irregularly shaped with extreme variation in size and have no 'starburst' pattern, are currently not present in teleosauroids.

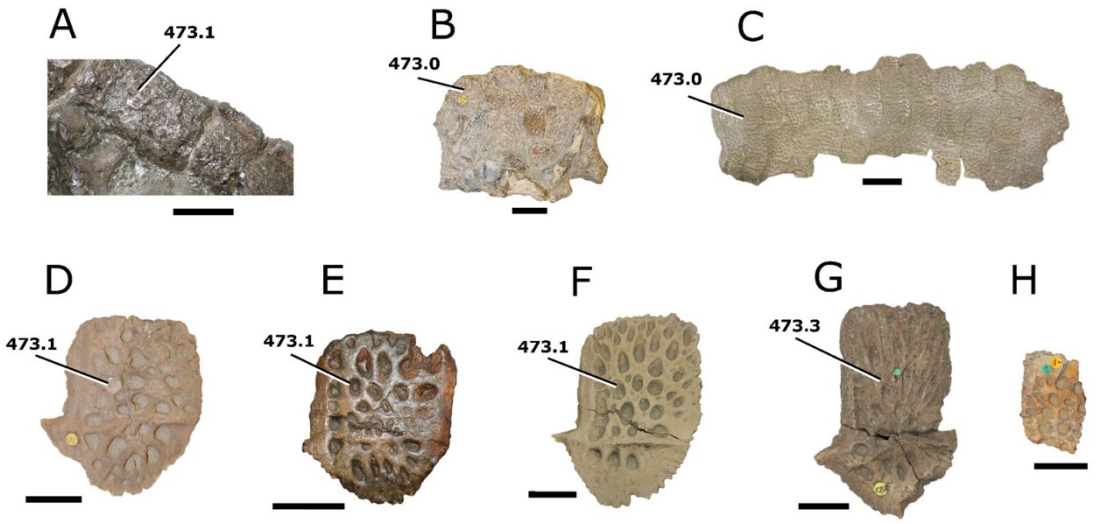


Figure 35. Comparative photographs of teleosauroid dorsal osteoderm ornamentation (from the sacral area) (ch. 473): (A) '*Steneosaurus*' *gracilirostris* (NHMUK PV OR 14792), (B) ?*Teleosaurus* sp. (NHMUK PV R 4143), (C) *Teleosaurus cadomensis* (NHMUK PV R 119a), (D) *Mycterosuchus nasutus* (NHMUK PV R 2617), (E) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806), (F) '*Steneosaurus*' *edwardsi* (PETMG R178), (G) *Lemmysuchus obtusidens* (NHMUK PV R 3168) and (H) '*Steneosaurus*' *baroni* (NHMUK PV R 1999). Scale bars: 3 cm.

Young et al. (2011a) first observed this difference in ornamentation, and it has since been modified in the following studies: Young et al. (2012); Young et al. (2013); Young (2014); Young et al. (2016); and Ristevski et al. (2018). The current iteration of this character can be found in Ősi et al. (2018), Foffa et al. (2019), Johnson et al. (2019) and Sachs et al. (2019a, 2019b).

UPDATED TELEOSAUROID TAXONOMY

This section offers a complete, up-to-date systematic palaeontological classification of all teleosauroid OTUs that were incorporated into my updated H+Y dataset. This classification scheme includes scientific name (a new genus is indicated by **gen. nov.**), type specimen (if applicable), etymology (if applicable), age, location(s), stratigraphic horizon(s), holotype, referred material (if applicable), scoring sources, emended diagnosis and extra remarks (if needed). Specific terminology used is as follows: a type is referred to as a particular specimen (or group of specimens) to which the scientific name of a specific species is based. The holotype refers to the individual (single specimen) used as the foundation for naming and describing a new taxon. A neotype refers to a particular specimen chosen to serve as the type specimen after the holotype is destroyed or lost; a lectotype refers to a specimen designated from syntypes (which are collection[s] of equal-status type specimens on which the description and name of a new species is based) to become the unique bearer of a species or taxon group; and a paralectotype is a specimen or number of specimens that help to define the scientific name a species represents that is not the holotype. Note that all definitions are in congruence with the International Code of Zoological Nomenclature (ICZN).

SYSTEMATIC PALAEONTOLOGY

CROCODYLOMORPHA Hay, 1930 (sensu Nesbitt 2011)

THALATTOSUCHIA Fraas, 1901 (sensu Young and Andrade 2009)

TELEOSAUROIDEA Geoffroy Saint-Hilaire, 1831 (sensu Young and Andrade 2009)

Gen. nov.

Plagiophthalmosuchus gracilirostris (Westphal, 1961)

(Fig. 36)

Type species: *Steneosaurus gracilirostris* Westphal, 1961. Now referred to as *Plagiophthalmosuchus gracilirostris* (Westphal, 1961), **comb. nov.**

Etymology: 'Lateral-eyed crocodile.' *Plágios* (πλάγιος) and *ofthalmós* (οφθαλμός) are Ancient Greek for 'lateral' and 'eye', respectively (referring to the laterally directed orbits of this taxon); *suchus* is the Latinized form of the Greek *soukhos* (σοῦχος), meaning crocodile.

Age: Lower Toarcian, Lower Jurassic.

Localities: Whitby, Yorkshire, UK; Dudelange-Bettembourg, southern Luxembourg.

Stratigraphic horizons: Alum Shale Member, Whitby Mudstone Formation, Lias Group; *Harpoceras serpentinum* ammonite Zone ('*schistes bitumineux*').

Holotype: NHMUK PV OR 14792, a nearly complete skeleton.

Paratype: NHMUK PV OR 15500, a complete skull and mandible.

Referred material: NHMUK PV OR 15500 (complete skull and mandible); MNHNL TU515 (nearly complete skull and mandible); YORM 2012.38 (nearly complete skull).

Scoring Sources: The holotype (NHMUK PV OR 14792), paratype and all referred specimens were studied first-hand. Additional photographs were provided by D. Lomax (DONMG specimen).

Autapomorphic characters: in the antorbital fenestrae, the external fenestra is larger than internal fenestra; antorbital fenestrae is moderately large, being at least half the diameter of the orbit; internal fenestra is approximately 50% of the length of the orbit; supratemporal fossa is slightly larger (~25%) than the length of the orbit; basioccipital sub-vertical and somewhat visible in occipital view; exoccipital-opisthotics are dorsoventrally slender and paraoccipital processes have a straight distal margin; orbit positioned laterally with a slight dorsal inclination; dorsal border at dentary-surangular is relatively straight; glenoid fossa of the articular oriented slightly anterodorsally.

Emended diagnosis: longirostrine snout; tooth row and quadrate condyle aligned, both at a lower level than the occipital condyle (shared with *Macrospondylus*); ornamentation absent on prefrontal (shared with *Indosinosuchus potamosiamensis*, *Bathysuchus*, *Sericodon* and *Aeolodon*) and lacrimal (shared with *I. potamosiamensis*, *Sericodon*, *Aeolodon* and *Macrospondylus*); greater than 67% of the total premaxillary length is posterior to the external nares (similar to the Chinese teleosauroid, *I. potamosiamensis*, *Mycterosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); external nares oriented anterodorsally (shared with the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); premaxillary anterior and anterolateral margins are not sub-vertical (shared with *Macrospondylus*, *Andrianavoay*, *Charitomenosuchus*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); antorbital fenestra is anteroposteriorly elongated (similar to *Deslongchampsina*); frontal broader than orbital width (shared with *Mystriosaurus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus*, *Aeolodon*, *Proexochokefalos* cf. *bouchardi*, *Neosteneosaurus*, *Machimosaurus buffetauti* and *Mac. mosae*); squamosal projects further posteriorly than the occipital condyle (shared with the Chinese teleosauroid, *Neosteneosaurus*, *Yvridiosuchus*, *Lemmysuchus* and *Mac. mosae*); orbit longitudinal ellipsoid in shape; basioccipital tubera reduced (shared with *Mycterosuchus*, *Bathysuchus* and *Sericodon*); supraoccipital dorsoventrally tall (shared with *Clovesuurdameredeor*, *Andrianavoay* and *Lemmysuchus*); angular straight and mainly horizontal, especially the anterior part (shared with *Mystriosaurus*); ventral margin of mandible is poorly curved (shared with *Mystriosaurus*); proximal humerus expanded and hooked (similar to *Platysuchus* and *Teleosaurus*); tibia evidently shorter than the femur (shared with *Platysuchus*).

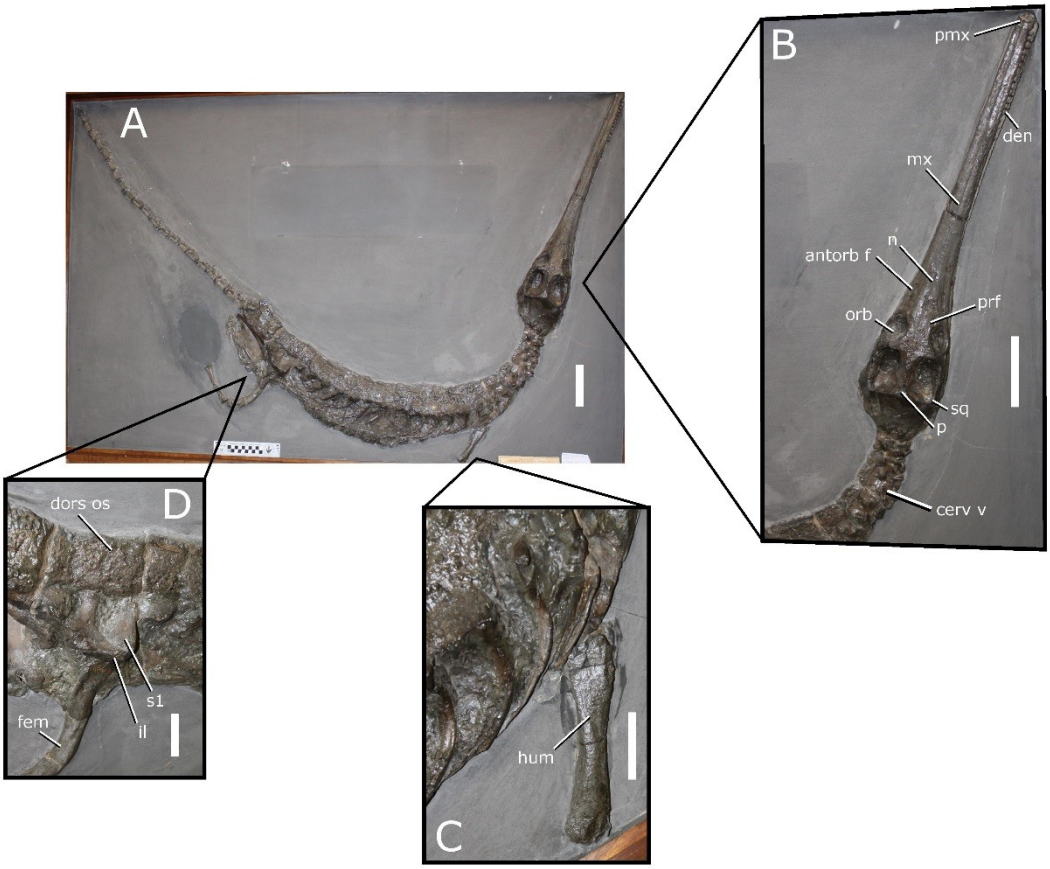


Figure 36. *Plagiophthalmosuchus gracilirostris* (Westphal, 1961) **comb. nov.**, NHMUK PV OR 14792, holotype. (A) Nearly complete skeleton, with close-up views of: (B) the skull, (B) forelimb and (D) pelvic area. Refer to abbreviations list. Scale bars: 10 cm (A-B) and 4 cm (C-D).

Mystriosaurus laurillardi Kaup, 1834

(Fig. 37-38)

Age: *Harpoceras serpentinum* Sub-Boreal ammonite Zone, Lower Toarcian, Lower Jurassic.

Localities: Altdorf, Germany; Whitby, Yorkshire, UK.

Stratigraphic horizons: Posidonia Shale Formation; Mulgrave Shale Member, Whitby Mudstone Formation, Lias Group.

Holotype: HLMD V946-948, a partial skull.

Referred material: NHMUK PV OR 14781 (nearly complete skull and mandible).

Scoring sources: NHMUK PV OR 14781 was studied first-hand. The holotype (HLMD V946-948) was examined using high quality photographs provided by S. Sachs, and also discussed at great length with S. Sachs.

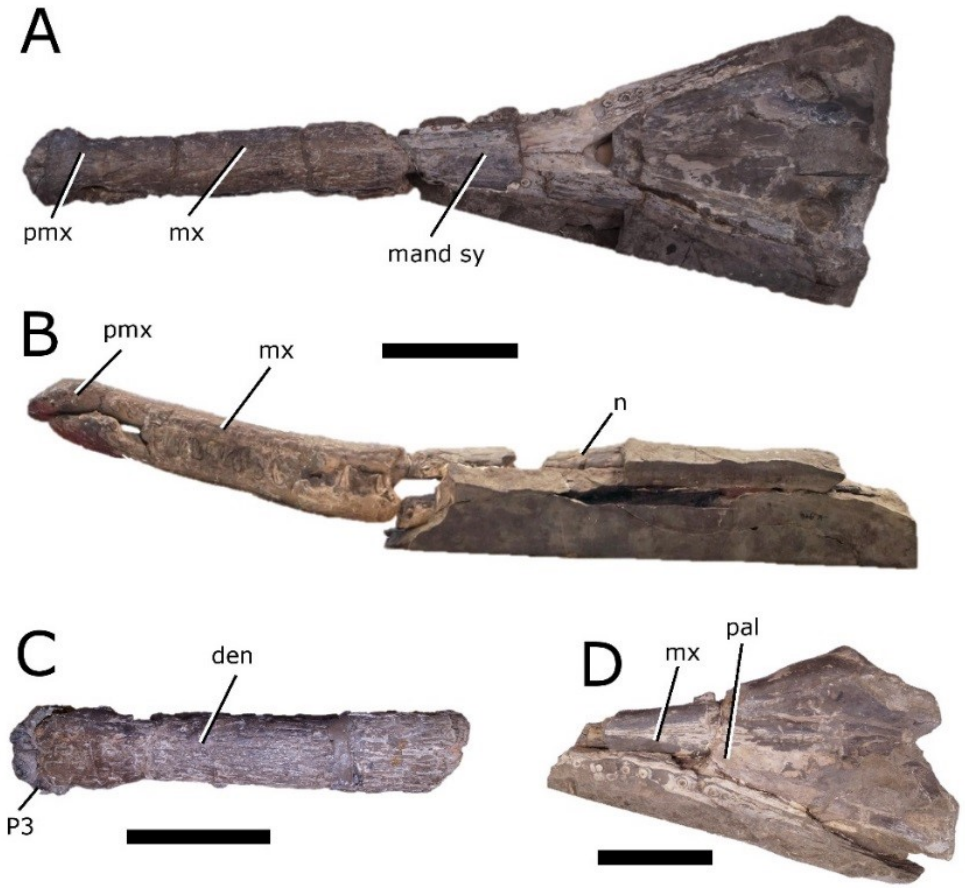


Figure 37. *Mystriosaurus laurillardi* Kaup, 1834, HLMD V946-948, holotype. (A, D) Dorsal, (B) left lateral and (C) ventral views. Refer to abbreviations list. Scale bars: 10 cm. Photographs provided by S. Sachs.

Autapomorphic characters: well-developed and extensive ornamentation on the nasals; external nares oriented anteriorly; antorbital fenestra is subrectangular in shape; supratemporal fossae form an approximate isosceles trapezoid-shape; medial margin of supratemporal arch relatively straight in dorsal view, with no significant concavity; prominent anterior notch in the dentaries; mandibular fenestra poorly elliptic; large, slightly robust teeth with numerous, conspicuous apicobasally aligned enamel ridges and a pointed apex, with more anteriorly-placed tooth crowns being procumbent.

Emended diagnosis: mesorostrine skull; well-developed and extensive ornamentation on the premaxillae, maxillae, frontal, prefrontal, lacrimal and postorbital; frontal ornamentation composed of small sub-circular to elongate pits that are closely spaced or, that can fuse and become a ridge-groove pattern (similar to *Mycterosuchus*); slight constriction of the snout anterior to the orbits (similar to *Deslongchampsina*); large and numerous neurovascular foramina on the premaxillae, maxillae and dentaries (shared with Machimosaurini); external nares 8-shaped in dorsal view (shared with the Chinese teleosauroid, *I. potamosiamensis*, *Bathysuchus* and *Aeolodon*); dorsoventrally deep premaxilla (similar to *Indosinosuchus* sp.); anteroposterior premaxillary length less than 25% of total rostral length (shared with the Chinese teleosauroid, *Mac. buffetauti* and *Mac. mosae*); premaxillary anterior and anterolateral margins are orientated anteroventrally and extend ventrally in lateral view (shared with the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Mycterosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); antorbital fenestrae almost equidistant to orbit and alveolar margin (shared with *Platysuchus*); antorbital fenestra is large relative to orbits (anteroposterior length is 25% orbital anteroposterior length) (similar to *Plagiophthalmosuchus* and *Deslongchampsina*); anterolateral margin of supratemporal fossae noticeably inclined anterolaterally (shared with the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus* and *Aeolodon*); the anterior region of the supratemporal fenestrae are very wide; frontal width broader than orbital width (shared with *Plagiophthalmosuchus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus*, *Aeolodon*, *Pr*. cf. *bouchardi*, *Neosteneosaurus*, *Mac. buffetauti* and *Mac. mosae*); very short frontal anteromedial process, being significantly shorter than the prefrontals when seen in dorsal view (similar to *Clovesuurdameredeor*); orbits subcircular in shape and dorsolaterally orientated; postorbital reaches orbit posteroventral margin (shared with the Chinese teleosauroid, *I. potamosiamensis*, *Platysuchus*, *Teleosaurus* and *Mycterosuchus*); mandibular symphysis slightly less than half the mandibular length, between 45 and 50% (shared with *I. potamosiamensis*, *Deslongchampsina* and *Proexochokefalos*); deep, well-developed reception pits throughout the anterior- to mid-maxilla and gradually disappear (similar to *Charitomenosuchus*, *Deslongchampsina* and

Proexochokefalos); ventral border of angular horizontal and poorly curved, especially the anterior part (shared with *Plagiophthalmosuchus*); four teeth per premaxilla; maxillary alveolar count at least 29 (modified from Young & Steel, in press) (similar to the Chinese teleosauroid, *I. potamosiamensis*, *Neosteneosaurus*, *Yvridiosuchus* and *Mac. buffetauti*); dentary alveolar count approximately 30 to 33 alveolar pairs; P1 and P2 both oriented anteriorly (shared with *I. potamosiamensis*, *Platysuchus*, *Macrospondylus*, *Deslongchampsina*, *Neosteneosaurus*, *Yvridiosuchus* and *Lemmysuchus*).

Remarks: The genus *Mystriosaurus* was initially coined by Kaup in 1834, but later was thought to be synonymous with '*Steneosaurus*.' It has recently been resurrected in Sachs et al. (2019b).

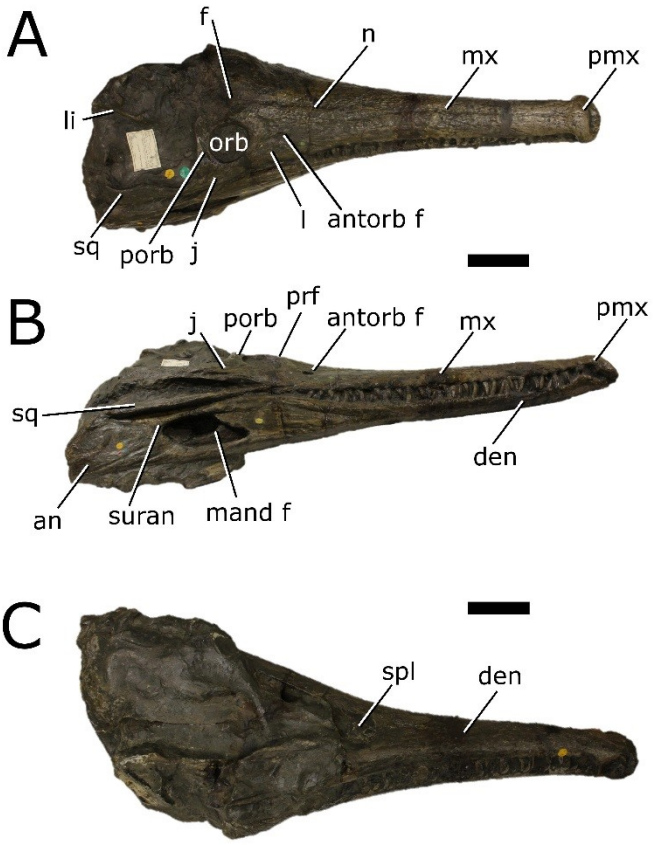


Figure 38. *Mystriosaurus laurillardi* Kaup, 1834, NHMUK PV OR 14781, referred specimen. (A) Dorsal, (B) right lateral and (C) ventral views. Refer to abbreviations list. Scale bars: 10 cm.

Gen. nov.

Clovesuurdameredeor stephani Hulke, 1877

(Fig. 39)

Type species: *Steneosaurus stephani* Hulke, 1877. Now referred to as *Clovesuurdameredeor stephani* (Hulke, 1877), **comb. nov.**

Etymology: 'Clovesuurda's sea creature'. '*Clovesuurda*' was the initial Medieval Latin name of the village of Closworth (written in the Doomsday Book of 1086), the locality where the holotype was found; *meredēor* is Old English for 'sea creature'.

Age: Bathonian, Lower Jurassic.

Locality: Closworth, Dorsetshire, UK.

Stratigraphic horizon: Great Oolite Group, Cornbrash Formation.

Holotype: NHMUK PV OR 49126, a partial skull and anterior section of mandible.

Scoring sources: The holotype (NHMUK PV OR 49126) was examined first-hand.

Autapomorphic characters: prefrontal is short and broad; anteromedial process of the frontal is posterior to the prefrontals; anteromedial process of the frontal is anteroposteriorly short and mediolaterally broad; jugal extends anteriorly to the prefrontal.

Emended diagnosis: frontal ornamentation extends from the centre to the lateral- and anterior-most areas (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus* and *Macrospondylus*); presence of small antorbital fenestrae; no anterolateral expansion or inclination of the supratemporal fenestrae (shared with *Plagiophthalmosuchus*, *Macrospondylus* , *Charitomenosuchus*, *Seldsienean*, *Deslongchampsina*, *Proexochokefalos*, *Pr*. cf. *bouchardi*,

Neosteneosaurus and Machimosaurini); frontal subequal to orbital width (shared with the Chinese teleosauroid, *Indosinosuchus* sp., *Macrospondylus*, *Charitomenosuchus*, *Deslongchampsina*, *Proexochokefalos*, *Yvridiosuchus*, *Mac. hugii* and *Mac. rex*); circular orbits (shared with *Mystriosaurus*, *Indosinosuchus*, *Teleosaurus*, *Mycterosuchus*, *Sericodon*, *Lemmysuchus* and *Machimosaurus*); anterior process of the jugal is slender and elongated (shared with *Charitomenosuchus*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini).

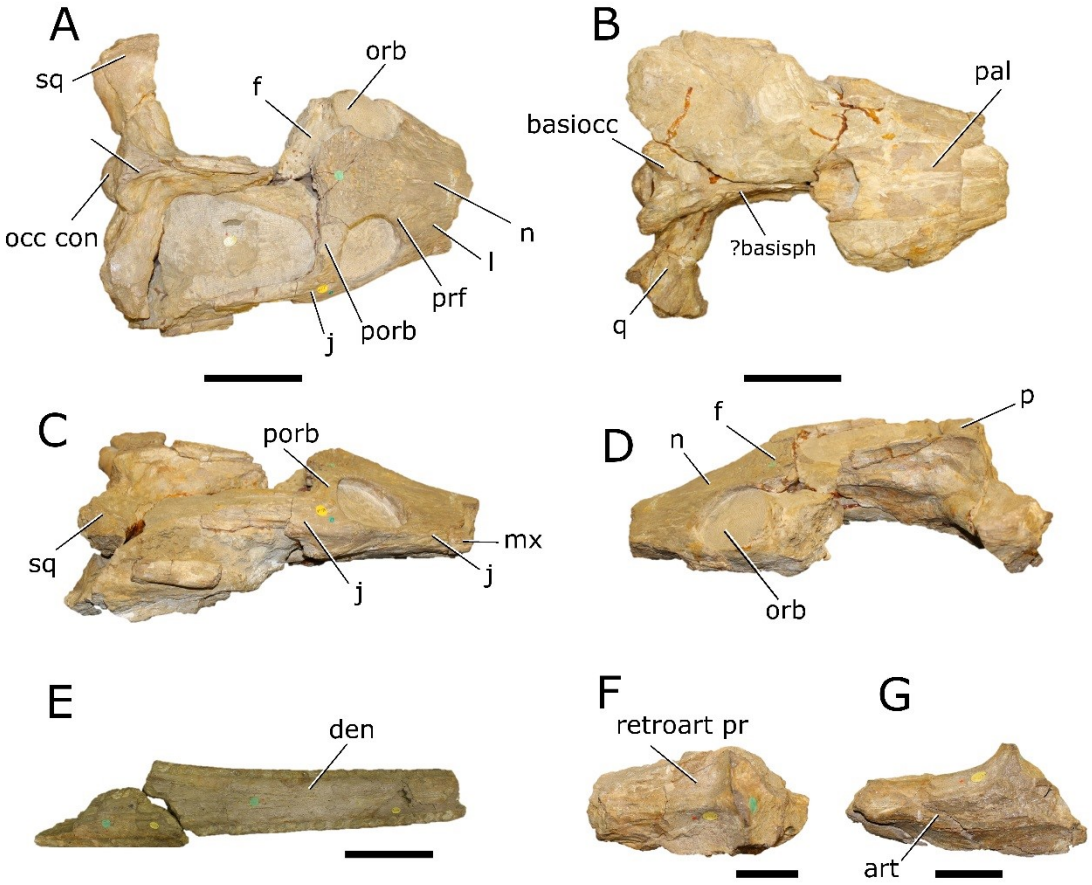


Figure 39. *Clovesuurdameredeor stephani* (Hulke, 1877), **comb. nov.**, NHMUK PV OR 49126, holotype. Skull in (A) dorsal, (B) ventral (palatal), (C) right and (D) left lateral views. Partial mandible in (E) dorsal view, and right retroarticular process in (F) dorsal and (G) right lateral views. Refer to abbreviations list. Scale bars: 10 cm (A-C) and 4 cm (E-F).

Chinese teleosauroid previously referred to as *Peipehsuchus teleorhinus* Young, 1948 (see Li, 1993)

(Fig. 40)

Age: Toarcian, Lower Jurassic.

Locality: Daxian, Szechuan, China.

Stratigraphic horizon: Ziliujing Formation.

Holotype: IVPP V 10098, a complete skull.

Scoring sources: The holotype (IVPP V 10098) was examined first-hand, and was also discussed in great length with E. Wilberg.

Autapomorphic characters: extreme constriction of premaxillae posterior to external nares (relative to other teleosauroids), creating a laterally expanded, 'beak-like' premaxilla; anterior- to mid-maxilla undulates mediolaterally in dorsal view; well-developed palatal canals; P1 and P2 oriented immediately laterally to one another, with the anterior-most margins of both alveoli sloping slightly anterolaterally; weak lateral expansion of the premaxilla (the P3 is situated marginally ventrally to the P2); P3 is enlarged relative to the P2 and roughly the same size as the P4*.

Emended diagnosis: mesorostrine skull; tooth row and occipital condyle aligned, and quadrate condyle at a lower level (shared with *Charitomenosuchus*, *Proexochokefalos*, *Pr.* cf. *bouchardi*, *Neosteneosaurus* and Machimosaurini); tooth row and occipital condyle aligned on the same plane with quadrate at a slightly lower level (similar to *Charitomenosuchus*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); shallow ornamentation of the premaxillae and maxillae (similar to *Indosinosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); frontal ornamentation extends from the centre to the lateral- and anterior-most areas (shared with *Plagiophthalmosuchus*, *Indosinosuchus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Macrospondylus* and *Clovesuurdameredeor*); external nares oriented anterodorsally (shared with *Plagiophthalmosuchus*, *Indosinosuchus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); external nares '8-shaped' in anterior view (shared with *Mystriosaurus*, *I. potamosiamensis*, *Bathysuchus* and *Aeolodon*); premaxillary anteroposterior length less than 25% of total rostral length (shared with *Mystriosaurus*, *Mac. buffetauti* and *Mac. mosae*); anterior and

anterolateral premaxillary margins are orientated anteroventrally and extend ventrally (shared with *Mystriosaurus*, *Indosinosuchus*, *Platysuchus*, *Mycterosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); over 67% of total premaxillary length posterior to the external nares (shared with *Plagiophthalmosuchus*, *I. potamosiamensis*, *Mycterosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); small antorbital fenestrae present; supratemporal fenestrae subrectangular in shape; anterolateral margin of supratemporal fossae noticeably inclined anterolaterally (shared with *Mystriosaurus*, *Indosinosuchus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus* and *Aeolodon*); frontal width subequal with orbital width (shared with *Indosinosuchus* sp., *Macrospondylus*, *Clovesuurdameredeor*, *Charitomenosuchus*, *Proexochokefalos*, *Yvridiosuchus*, *Mac. hugii* and *Mac. rex*); squamosal project further posteriorly than occipital condyle (shared with *Plagiophthalmosuchus*, *Neosteneosaurus*, *Yvridiosuchus*, *Lemmysuchus* and *Mac. mosae*); orbit anteroposteriorly elongated and ellipsoid in shape (similar to *Plagiophthalmosuchus*, *Platysuchus*, *Aeolodon*, *Macrospondylus*, *Charitomenosuchus*, *Seldsienean*, *Deslongchampsina*, *Proexochokefalos*, *Pr*. cf. *bouchardi* and *Neosteneosaurus*); postorbital reaches the orbit posteroventral margin (shared with *Mystriosaurus*, *I. potamosiamensis*, *Platysuchus*, *Teleosaurus* and *Mycterosuchus*); pterygoid flange oriented horizontally (shared with *Teleosaurus*); four premaxillary alveolar pairs; 27 maxillary alveolar pairs; P3 and P4 do not form a couple (shared with *Bathysuchus*); small P1 compared to the P2 (similar to *Macrospondylus*).

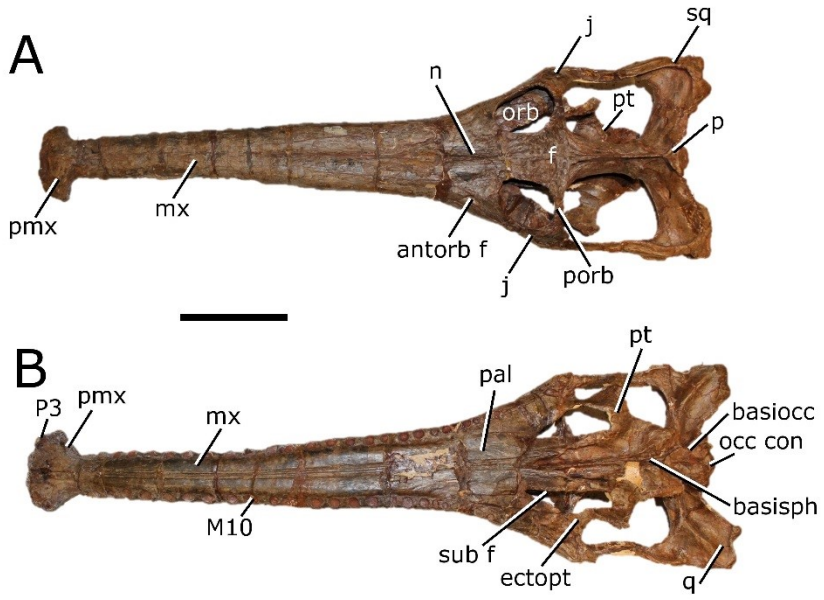


Figure 40. The Chinese teleosauroid previously referred to as *Peipehsuchus* (see Li, 1993), IVPP V 10098, holotype. Skull in (A) dorsal and (B) ventral (palatal) views. Refer to abbreviations list. Scale bars: 10 cm.

Remarks: This taxon, along with the holotype of *Peipehsuchus teleorhinus* (IVPP RV 48001), is currently being re-described by E. Wilberg, M.M. Johnson, H. Yi and J. Chen.

Platysuchus multiscrobiculatus (Berckhemer, 1929) Westphal, 1961

(Fig. 41)

Age: Lower Toarcian, Lower Jurassic.

Localities: Holzmaden, Baden-Württemberg, Germany; Foetz, Luxembourg.

Stratigraphic horizons: Posidonia Shale Formation; *Harpoceras serpentinum* ammonite Zone (‘*schistes bitumineux*’).

Holotype: SMNS 9930, a nearly complete skeleton.

Referred material: MNHNL TU895 (a partial rostrum).

Scoring sources: The holotype (SMNS 9930) was examined first-hand, and further discussed with M. Young. MNHNL TU895 was also examined in person. Additional information was taken from Westphal (1961, 1962).

Autapomorphic characters: prefrontal and lacrimal both ornamented with meandering, elongated grooves; mid- and posterior squamosal well ornamented with small, circular, closely packed pits; frontal width is wider than the parietal; jugal excluded from the orbit by lacrimal-postorbital contact; P1 and P2 do not form a couplet and are not oriented on the anterior margin of the premaxilla; tuberculum of the dorsal rib medium-sized; ischium with thickened, robust ischial neck; shortened, stocky pubis with a relatively sub-circular proximal rim;

Emended diagnosis: longirostrine snout; tooth row and quadrate condyle unaligned with the tooth row at a lower level, and both below the occipital condyle (shared with *Teleosaurus*); tooth row at a lower level than the quadrate (shared with *Plagiophthalmosuchus*, *Indosinosuchus*, *Teleosaurus*, *Mycterosuchus* and *Macrospondylus*); frontal ornamentation extends from the centre to lateral- and anterior-most regions (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Indosinosuchus*, *Teleosaurus*, *Mycterosuchus*, *Macrospondylus* and *Clovesuurdameredeor*); external nares oriented anterodorsally (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Indosinosuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); the premaxillary anterior and anterolateral margins are orientated anteroventrally and extend ventrally (shared with *Mystriosaurus*, the Chinese teleosauroid, *Indosinosuchus*, *Mycterosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); presence of small, mediolaterally thin antorbital fenestrae; anterior margin of the supratemporal fossae are noticeably inclined anterolaterally (shared with *Mystriosaurus*, the Chinese teleosauroid, *Indosinosuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus* and *Aeolodon*); frontal width is broader than orbital width (shared with *Plagiophthalmosuchus*, *Mystriosaurus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus*, *Aeolodon*, *Pr*. cf. *bouchardi*, *Neosteneosaurus*, *Mac. buffetauti* and *Mac. mosae*); frontal-postorbital suture is lower than the intertemporal bar (shared with *Teleosaurus*); orbits

are longitudinal ellipsoid in shape (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Macrospondylus*, *Charitomenosuchus*, *Aeolodon*, *Seldsienean*, *Pr*. cf. *bouchardi*, *Proexochokefalos*, *Deslongchampsina* and *Neosteneosaurus*); postorbital reaches the orbit posteroventral margin and forms an extensive area of the orbit ventral margin (shared with *Mystriosaurus*, *Indosinosuchus*, the Chinese teleosauroid, *Teleosaurus* and *Mycterosuchus*); five premaxillary alveoli (shared with *Teleosaurus*, *Bathysuchus* and *Sericodon*); interalveolar spacing between P1-P2 and P3-P4 relatively the same size (shared with *Mycterosuchus*, *Bathysuchus* and *Sericodon*); anterior maxillary teeth procumbent (shared with *Plagiophthalmosuchus*, *Indosinosuchus* sp., *Teleosaurus*, *Sericodon*, *Aeolodon*, *Macrospondylus* and *Charitomenosuchus*); neural spine height is greater than centrum height (similar to *Neosteneosaurus*); tuberculum of dorsal rib situated on the medial edge (shared with *Aeolodon*, *Macrospondylus* and *Lemmysuchus*); shortened and squat scapula (similar to *Macrospondylus*); proximal humerus posteriorly expanded and weakly hooked (shared with *Teleosaurus*); forelimb relatively shorter than hindlimb by approximately 22% (similar to *Macrospondylus*); tibia shorter than the femur by approximately 25% (similar to *Macrospondylus*); small round to ellipsoid pits on all osteoderms that are very densely distributed, with a ‘honeycomb’ pattern (shared with *Teleosaurus*); presacral osteoderms are

strongly curved and closely locked together, forming a dorsal 'shield' (shared with *Teleosaurus*).

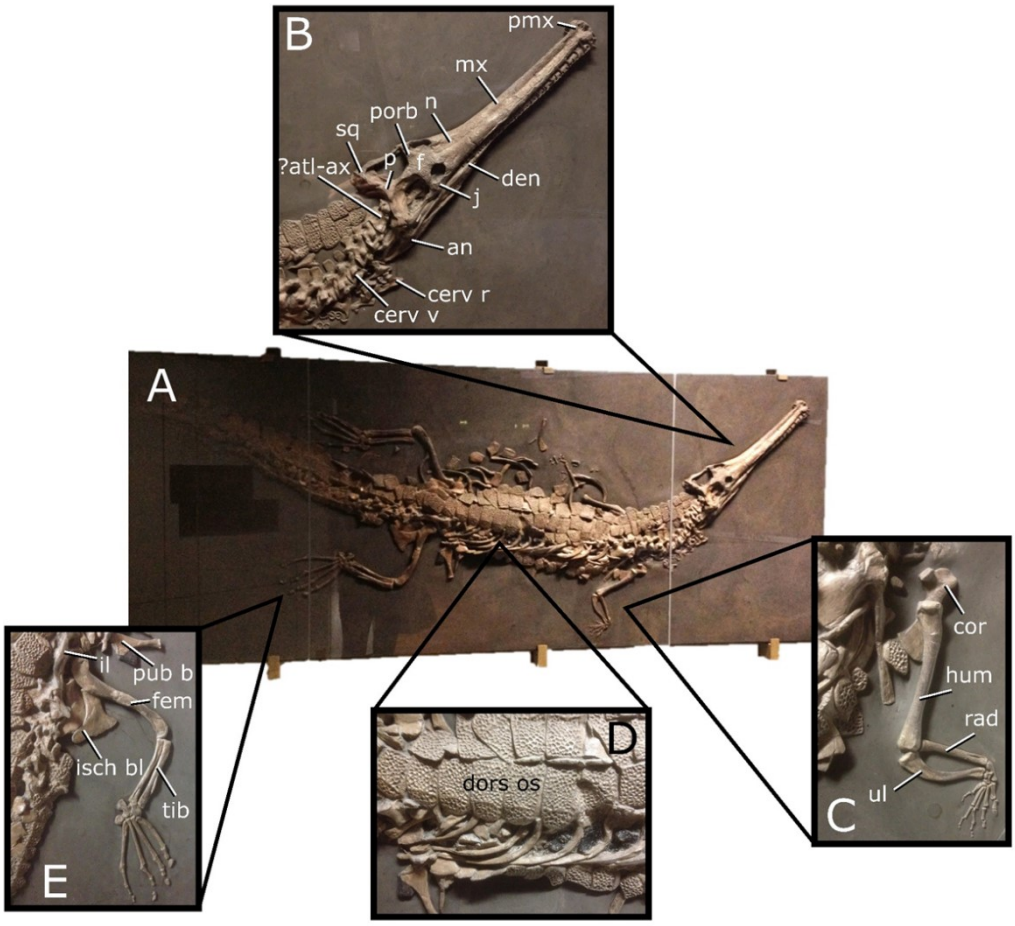


Figure 41. *Platysuchus multiscrobiculatus* (Berckhemer, 1929) Westphal, 1961, SMNS 9930, holotype. (A) Nearly complete skeleton, with close-up views of (B) the skull, (C) forelimb, (D) trunk region and (E) hindlimb. Refer to abbreviations list. Not to scale.

Teleosaurus cadomensis (Lamouroux, 1820)

(Fig. 42)

Age: Bathonian, Middle Jurassic.

Locality: Allemagne, 3km south of Caen, Calvados, Normandy, France.

Stratigraphic horizon: '*Calcaire de Caen*'.

Holotype: Complete skull, initially mentioned by Lamouroux (1820) and fully described by Geoffroy Saint-Hilaire (1825). Destroyed in 1994 (noted by Vignaud [1995] to be the lectotype).

Neotype: MNHN.F AC 8746, a partially complete skull (described by Jouve, 2009).

Designation of neotype: Herein we formally designate MNHN.F AC 8746 as the neotype of *T. cadomensis*. In order to be in full accordance of Article 75 of the ICZN Code, specifically Article 75.3, we make the following statements:

1. This designation is made with the purpose of clarifying the taxonomic status of *T. cadomensis*.
2. Our statement of the characters that we regard as differentiating *T. cadomensis* from other taxa is listed in the species diagnosis below.
3. The neotype can be recognized through both the diagnosis below and Fig. 42.
4. The holotype is presumed destroyed in 1944 during the bombing of Caen.
5. The holotype consisted of a complete skull; the figures and descriptions given by Cuvier (1824), Geoffroy Sainte-Hilaire (1825), J.A. Eudes-Deslongchamps (1868d), and E. Eudes-Deslongchamps (1867-69) show it to be a gracile, longirostrine skull with protruding orbits, an elongated nasal with an acute anterior portion and shortened, box-like supratemporal fenestrae. As such, the neotype is consistent with what is known of the former name-bearing type.
6. Geoffroy Saint-Hilaire (1825) described, figured and designated MNHN.F AC 8746 as *Teleosaurus cadomensis* (pp. 135-145, pl. 6), "*pour qualifier et nommer l'espèce perdue*" ("to qualify and to name the lost species") of Lamouroux (1820);
7. The neotype is from the same stratigraphic horizon and country as the holotype.

8. The neotype is the property of a recognized scientific institution, MNHN, which maintains a research collection with proper facilities for preserving name-bearing types, and is accessible for study.

Referred material: NHMUK PV OR 119a (dorsal osteoderms); NHMUK PV R 4207 (dorsal osteoderms); NHMUK PV OR 32588 (dorsal, sacral and caudal vertebrae); NHMUK PV OR 32657 (femur); NHMUK PV OR 32680 (ischium); NHMUK PV OR 33124 (mandibular symphysis); NHMUK PV OR 39788 (partial rostrum); and additional casts (e.g. NHMUK PV R 880 and NHMUK PV R 880a).

Scoring sources: The neotype and all referred material mentioned above was studied first-hand. Lamouroux (1820), Geoffroy Saint-Hilaire (1825), Eudes-Deslongchamps (1867-69), Vignaud (1995) and Jouve (2009) also provided additional information.

Autapomorphic characters: presence of small, subcircular, shallow antorbital fenestrae; supratemporal fenestrae box- or square-shaped; postorbital and squamosal are relatively the same length, with the squamosal being slightly longer; choanae mediolaterally wider than palatines.

Emended diagnosis: longirostrine, gracile snout; tooth row and quadrate condyle unaligned with the tooth row at a lower level, and both below the occipital condyle (shared with *Platysuchus*); tooth row at a lower level than the quadrate (shared with *Plagiophthalmosuchus*, *Indosinosuchus*, *Platysuchus*, *Mycterosuchus* and *Macrospondylus*); rostrum narrows immediately anterior to the orbits (shared with *I. potamosiamensis*, *Mycterosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); frontal ornamentation extends from the centre to lateral- and anterior-most regions (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Mycterosuchus*, *Macrospondylus* and *Clovesuurdameredeor*); external nares oriented anterodorsally (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Mycterosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); the anterior and anterolateral margins of the premaxillae are orientated anteroventrally and extend ventrally (shared with *Mystriosaurus*, the Chinese

teleosauroid, *Indosinosuchus*, *Mycterosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); anterior margin of the supratemporal fossae are noticeably inclined anterolaterally (shared with *Mystriosaurus*, the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Mycterosuchus*, *Bathysuchus* and *Aeolodon*); anteromedial projection of the frontal is relatively broad but becomes instantly mediolaterally thin at the anterior-most part (shared with *Sericodon*); frontal width is broader than orbital width (shared with *Plagiophthalmosuchus*, *Mystriosaurus*, *Platysuchus*, *Mycterosuchus*, *Bathysuchus*, *Aeolodon*, *Pr*. cf. *bouchardi*, *Neosteneosaurus*, *Mac. buffetauti* and *Mac. mosae*); frontal-postorbital suture is lower than the intertemporal bar (shared with *Platysuchus*); dorsal margins of orbits upturned (shared with *I. potamosiamensis*, *Mycterosuchus* and *Aeolodon*); postorbital reaches the orbit posteroventral margin and forms an extensive area of the orbit ventral margin (shared with *Mystriosaurus*, *Indosinosuchus*, the Chinese teleosauroid, *Platysuchus* and *Mycterosuchus*); pterygoid flange oriented horizontally (shared with the Chinese teleosauroid); five premaxillary alveolar pairs (shared with *Platysuchus*, *Bathysuchus* and *Sericodon*); anterior maxillary teeth procumbent (shared with *Indosinosuchus*, *Platysuchus*, *Aeolodon*, *Sericodon*, *Macrospondylus* and *Charitomenosuchus*); proximal humerus posteriorly expanded and weakly hooked (shared with *Platysuchus*); small round to ellipsoid pits that are very densely distributed, with a ‘honeycomb’ pattern (shared with *Platysuchus*); presacral osteoderms are strongly curved and closely locked together, forming a dorsal ‘shield’ (shared with *Platysuchus*).

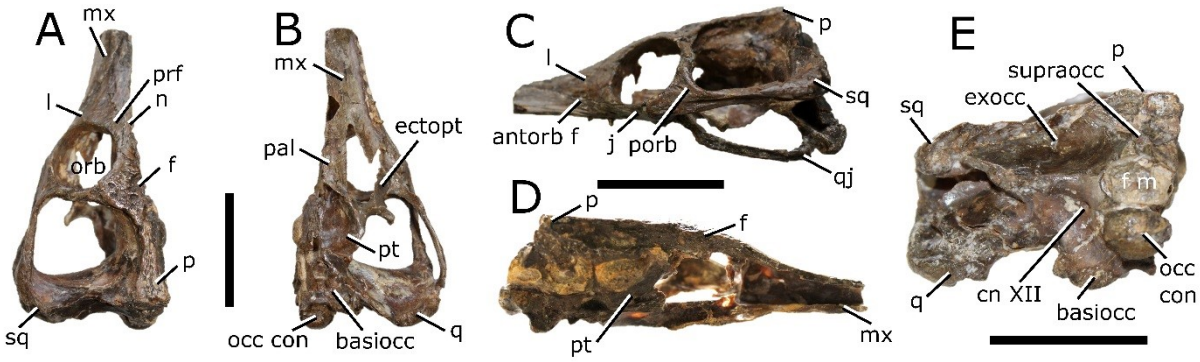


Figure 42. *Teleosaurus cadomensis* (Lamouroux, 1820), MNHN AC 8746, neotype. Partial skull in (A) dorsal, (B) ventral (palatal), (C) left lateral, (D) right lateral and (E) occipital views. Refer to abbreviations list. Scale bars: 5 cm.

Mycterosuchus nasutus (Andrews, 1909) Andrews, 1913

(Fig. 43-44)

Age: Middle Callovian, Middle Jurassic.

Locality: Peterborough, UK.

Stratigraphic horizon: Peterborough Member, Oxford Clay Formation, Ancholme Group.

Holotype: NHMUK PV R 2167, a complete skull and mandible, with additional material (including vertebrae [cervical, dorsal, sacral and caudal], cervical and dorsal ribs, scapulocoracoid, two femora [both broken], one radius, one ulna, multiple phalanges and tarsals, isolated teeth and multiple dorsal osteoderms).

Referred material: CAMSM J.1420 (a nearly complete skeleton); NHMUK PV R 3892 (dorsal and sacral vertebrae); NHMUK PV R 4059 (a partial skull); unnumbered GZG specimen (a complete skull). Possible NM partial skeleton (catalogue number unknown, photographs provided by B. Ekrt).

Scoring sources: The holotype (NHMUK PV R 2167) and all referred material (excluding the NM skeleton) mentioned above were studied first-hand.

Autapomorphic characters: overall cranium and mandible extremely rugose; elongate, slender rostrum (roughly 73% of total skull length); maxilla ornamented with an array of irregular patterns of deep rugosities and anastomosing grooves; relatively reduced quadrate condyles; palatine anterior margin terminates level to 29th maxillary alveoli, or more distal alveoli; curvature of the angular is gradual in the anterior region, but more abrupt in the posterior-most region; on the retroarticular process, the length of the attachment surface for the adductor muscles is more than twice its width; D1 strongly anteriorly oriented; the neural arches of the posterior cervical vertebrae are taller than the vertebral centra; the posterior edge of

the scapula is more strongly concave than the anterior edge; the humeral head is weakly posteriorly expanded and hooked with a club-like shape; the ulna is more than 25% larger than the radius; the pubic shaft is over 50% length of the pubic plate; forelimb length slightly shorter than hindlimb length; anteromedial tuber of the femur is the largest of the proximal tubera; calcaneal tuber approximately 25% of astragalus; large, heavyset dorsal osteoderms with large, round-to-ellipsoid (D-shaped) irregular pits that are well separated from one another.

Emended diagnosis: longirostrine snout; tooth row and quadrate condyle unaligned and quadrate at a lower level, but both below the occipital condyle (shared with *Indosinosuchus*); well-developed and extensive ornamentation on the premaxillae, maxillae, frontal, prefrontal, lacrimal and postorbital; frontal ornamentation composed of small sub-circular to elongate pits that are closely spaced or, that can fuse and become a ridge-groove pattern (similar to *Mystriosaurus*); rostrum narrows immediately anterior to the orbits (shared with *I. potamosiamensis*, *Teleosaurus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); the anterior and anterolateral margins of the premaxillae are strongly anteroventrally deflected and extend ventrally (shared with *Mystriosaurus*, the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); more than 67% of the premaxillae total length is posterior to the external nares (shared with *Plagiophthalmosuchus*, *I. potamosiamensis*, the Chinese teleosauroid, *Bathysuchus*, *Sericodon* and *Aeolodon*); external nares are ‘8’ shaped in dorsal view due to enlarged anterior and posterior projections of the of the premaxilla (shared with *Bathysuchus*); external nares are anterodorsally oriented (shared with *Mystriosaurus*, the Chinese teleosauroid, *Platysuchus* and *Bathysuchus*); clustering of large, circular foramina along lateral margin of external nares (similar to *Mystriosaurus*, *Indosinosuchus* sp. and Machimosaurini); small, subcircular antorbital fenestrae; the anterior margin of the supratemporal fossae are noticeably inclined anterolaterally (shared with *Mystriosaurus*, the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Teleosaurus*, *Bathysuchus* and *Aeolodon*); frontal width broader than orbital width (shared with *Plagiophthalmosuchus*, *Mystriosaurus*, *Platysuchus*, *Teleosaurus*, *Bathysuchus*, *Aeolodon*, *Neosteneosaurus*, *Mac. buffetauti* and

Mac. mosae); circular orbits (shared with *Mystriosaurus*, *Teleosaurus*, *Indosinosuchus*, *Clovesuurdameredeor* and Machimosaurini); dorsal margins of orbits are upturned (shared with *I. potamosiamensis*, *Teleosaurus* and *Aeolodon*); postorbital reaches the orbit posteroventral margin and extensively forms part of the orbit ventral margin (shared with *Mystriosaurus*, the Chinese teleosauroid, *I. potamosiamensis*, *Platysuchus* and *Teleosaurus*); reduced basioccipital tubera (similar to *Plagiophthalmosuchus*, *Bathysuchus* and *Sericodon*); mandibular symphysis over 50% of mandible length (shared with *Bathysuchus*, *Aeolodon*, *Macrospondylus*, *Seldsienean* and *Charitomenosuchus*); mandibular symphysis depth is very narrow, approximately 4-4.5% of the mandible length (shared with *Charitomenosuchus*); the P1 and P2 do not form a couplet, and the interalveolar spacing between the P1-P2 and P3-P4 are relatively the same size (shared with *Platysuchus*, *Bathysuchus* and *Sericodon*); both the P1 and P2 alveoli are oriented laterally (shared with *Bathysuchus* and *Sericodon*); the P1 and P2 do not form a couplet but are still oriented on the anterior margin of the premaxilla (shared with *Bathysuchus* and *Sericodon*); P1 and P2 are on the same transvers plane (shared with *Bathysuchus*, *Sericodon* and *Aeolodon*); teeth slender, pointed and weekly mediolaterally compressed (shared with *Bathysuchus* and *Aeolodon*); the tubercula and articular facets in the dorsal ribs are positioned directly in the middle (shared with *Charitomenosuchus*); the tubercula in the dorsal ribs are large and pronounced (shared with *Neosteneosaurus* and Machimosaurini); tibia roughly 40-50% shorter than the femur (shared with *Charitomenosuchus*, *Neosteneosaurus* and Machimosaurini); the medial femoral condyle is noticeably larger than the lateral femoral condyle (shared with *Charitomenosuchus* and *Neosteneosaurus*).

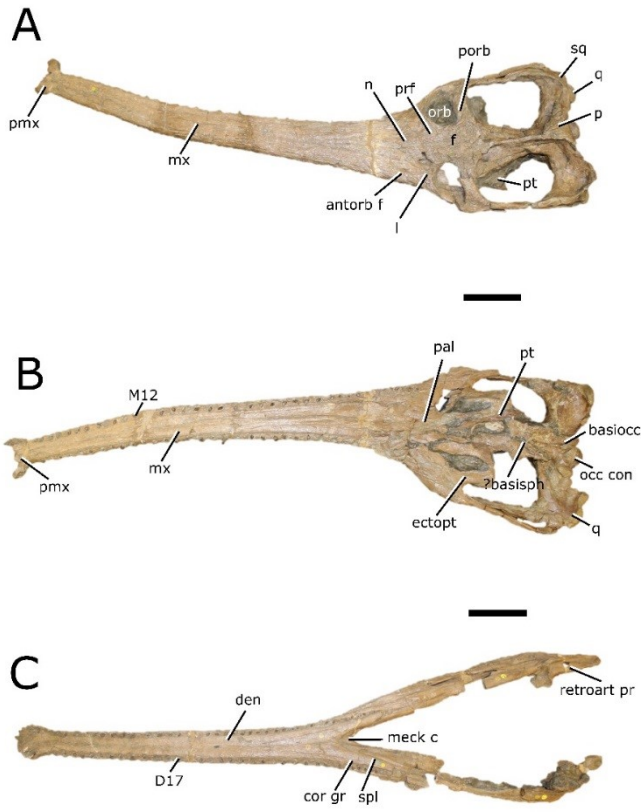


Figure 43. *Mycterosuchus nasutus* Andrews, 1913, NHMUK PV R 2617, holotype. Skull in (A) dorsal and (B) ventral (palatal) views, and dentary in (C) dorsal view. Note the extremely rugose dorsal cranium. Refer to abbreviations list. Scale bars: 10 cm.

Remarks: The skull and mandible of the NHMUK holotype was originally numbered PV R 2617, along with the associated postcranial material. The skull and mandible were then reregistered PV R 3577 in error (what year and by whom is unknown). *Mycterosuchus* has also been considered as a synonym of *Charitomenosuchus* in certain studies (e.g. Vignaud, 1995).

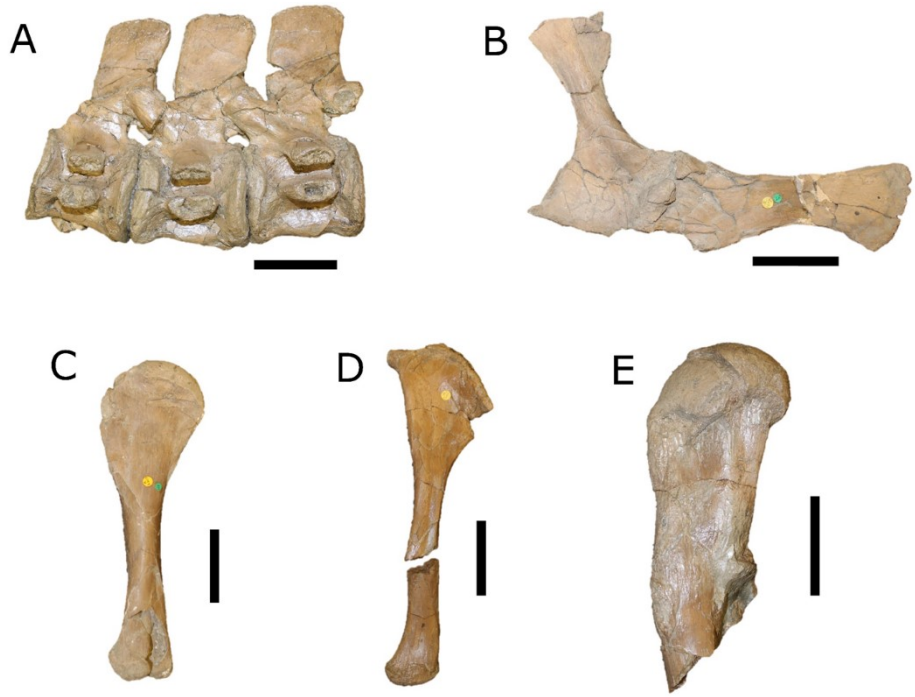


Figure 44. *Mycterosuchus nasutus Andrews*, 1913, NHMUK PV R 2617, holotype. Select postcranial elements, including: (A) three cervical vertebrae, (B) scapulocoracoid, (C) humerus, (D) pubis and (E) proximal femur. Note the rounded humeral head and elongated pubic shaft. Scale bars: 5 cm.

Aeolodon priscus (von Sömmering, 1814)

(Fig. 45)

Age: Lower Tithonian, Upper Jurassic.

Localities: Daiting, southern Germany; Canjuers, Var, France.

Stratigraphic horizons: Mörnsheim Formation; Canjuers conservation Lagerstätte.

Holotype: NMHUK PV R 1086, a nearly complete skeleton.

Referred material: MNHN.F.CNJ 78 (nearly complete skeleton).

Scoring sources: The holotype (NMHUK PV R 1086) and referred specimen (MNHN.F.CNJ 78a) were both studied first-hand.

Autapomorphic characters: shallow elliptical pits on the frontal; length of the attachment surface for the *m. pterygoideus posterior* on the retroarticular process is short, and subequal to its width; neural spine and centrum heights of the mid-cervical vertebrae are approximately equal; distal coracoid with rounded edges and a deep coracoid foramen; extremely shortened ulna and radius relative to humerus; ulna with little curvature, only in the proximal-most region; metacarpals IV and V are similar in robusticity to II-III ; ischial plate sub-triangular; tibia 30-40% shorter than the femur; dorsal osteoderm ornamentation consists of large, well-spaced circular pits.

Emended diagnosis: longirostrine skull; rostrum narrows immediately anterior to the orbits (shared with *I. potamosiamensis*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus* and *Sericodon*); shallow, inconspicuous ornamentation of the premaxillae and maxillae (similar to the Chinese teleosauroid, *Indosinosuchus*, *Bathysuchus* and *Sericodon*); no ornamentation on the prefrontal (shared with *Plagiophthalmosuchus*, *I. potamosiamensis*, *Bathysuchus* and *Sericodon*) and lacrimal (shared with *Plagiophthalmosuchus*, *I. potamosiamensis*, *Sericodon*, *Macrospondylus* and *Charitomenosuchus*); frontal ornamentation restricted to centre (shared with *Sericodon*, *Charitomenosuchus*, *Seldsienean*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); external nares oriented anterodorsally (shared with *Mystriosaurus*, the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Mycterosuchus*, *Bathysuchus* and *Sericodon*); external nares noticeably ‘8’-shaped in anterior view (shared with *Mystriosaurus*, the Chinese teleosauroid, *I. potamosiamensis* and *Bathysuchus*); the anterior and anterolateral premaxillary margins are orientated anteroventrally and extend ventrally (shared with *Mystriosaurus*, the Chinese teleosauroid, *Platysuchus*, *Mycterosuchus* and *Bathysuchus*); subrectangular supratemporal fenestrae; the anterior margin of the supratemporal fossae are noticeably inclined anterolaterally (shared with *Mystriosaurus*, the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus* and *Bathysuchus*); frontal width is broader than orbital width (shared with *Plagiophthalmosuchus*, *Mystriosaurus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus*, *Pr*. cf. *bouchardi*, *Neosteneosaurus*, *Mac. buffetauti* and *Mac. mosae*); orbits are longitudinal

ellipsoid in shape (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Platysuchus*, *Macrospondylus*, *Charitomenosuchus*, *Seldsienean*, *Pr*. cf. *bouchardi*, *Proexochokefalos*, *Deslongchampsina* and *Neosteneosaurus*); the dorsal margins of the orbits are upturned (shared with *I. potamosiamensis*, *Teleosaurus* and *Mycterosuchus*); angular poorly curved (somewhat similar to *Plagiophthalmosuchus* and *Mystriosaurus*); mandibular symphysis is over 50% of the mandible length (shared with *Mycterosuchus*, *Bathysuchus*, *Macrospondylus*, *Charitomenosuchus* and *Seldsienean*); retroarticular width subequal to the glenoid fossa (shared with *Lemmysuchus* and *Mac. buffetauti*); P1 and P2 are both on the same transverse plane (shared with *Mycterosuchus*, *Bathysuchus* and *Sericodon*); the premaxilla lateral margins are subrectangular, with the P3 alveoli being clearly lateral to the P2 alveoli (shared with *Mycterosuchus*, *Bathysuchus* and *Sericodon*); at least 22 dentary alveolar pairs; premaxillary and anterior maxillary apicobasal length to basal width ratio of the tooth crown is 3 or greater (shared with *Macrospondylus* and *Charitomenosuchus*); shallow tuberculum on the dorsal ribs (shared with *Macrospondylus* and *Charitomenosuchus*); the proximal region of the humerus is very strongly posteriorly deflected and hooked (shared with *Charitomenosuchus* and *Neosteneosaurus*); femoral condyles are relatively the same size (shared with *Macrospondylus*, *Platysuchus* and *Lemmysuchus*); pits on dorsal osteoderms arranged in alternating rows (similar to *Bathysuchus*); dorsal osteoderms reduced in size and thickness (shared with *Bathysuchus*).

Remarks: *Crocodilus* (*Aeolodon*) *priscus* (NHMUK PV R 1086) was the first teleosauroid genus to be scientifically named by von Sömmering in 1814. It is also interesting to note that Geoffroy Saint-Hilaire (1831: 48) did not believe that *Aeolodon* ("*le gavial de Sömmering*": "Sömmering's gavial") could be referred to as either *Teleosaurus* or '*Steneosaurus*' (mainly due to the fact that it was not found in the deposits near Caen, which Geoffroy Saint-Hilaire believed these two genera were restricted to).

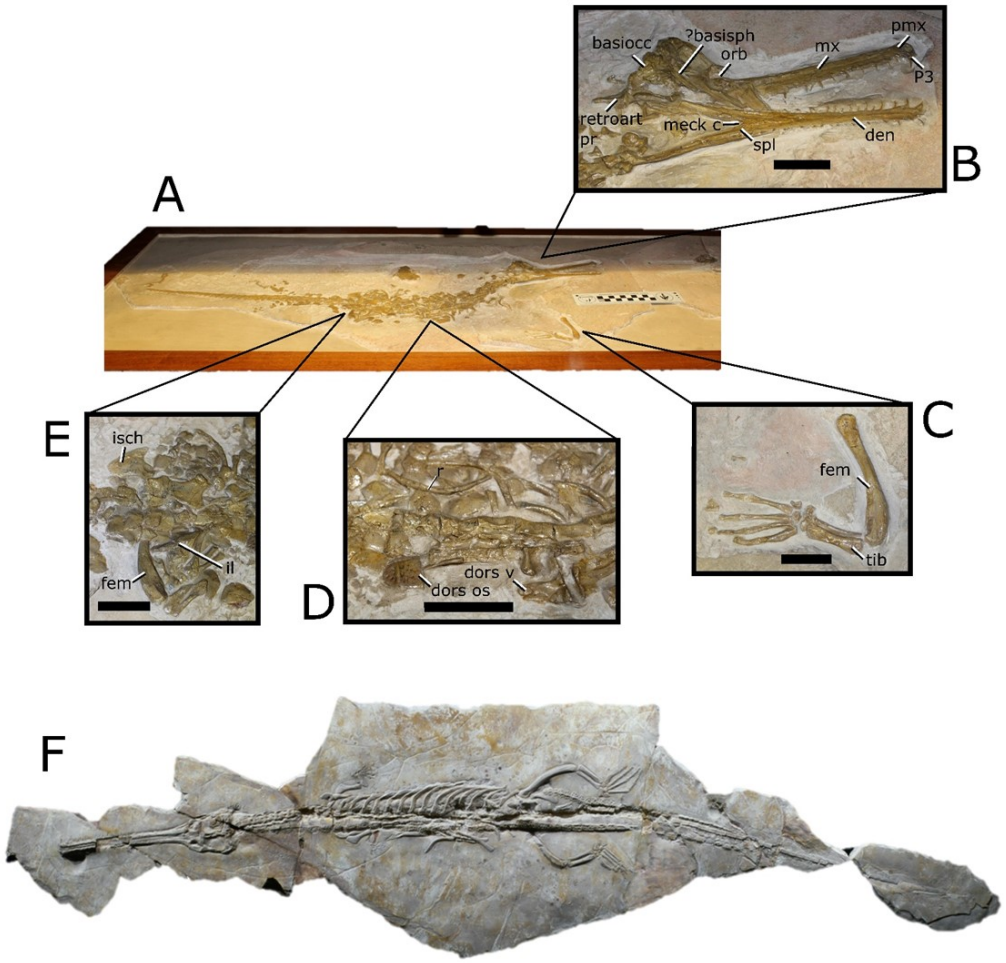


Figure 45. *Aeolodon priscus* (von Sömmering, 1814), (A-E) NHMUK PV R 1086, holotype and (F) MNHN.F.CNJ 78, referred specimen (modified from Foffa et al. (2019; Figure 10). (A) Partial skeleton with close-ups of (B) the skull, (C) hindlimb, (D) trunk region and (E) pelvic area. (F) Nearly complete skeleton. Scale bars: 10 cm (A) and 3 cm (B-E), (F) not to scale.

Despite coming from different localities, the holotype (NHMUK PV R 1086) and referred specimen (MNHN.F.CNJ 78) share the following combination of features:

1. A longirostrine, weakly ornamented skull;
2. Protruding orbits;
3. Neural spine and centrum of the mid-cervical vertebrae are approximately equal in height;
4. Distal coracoid with rounded edges and deep coracoid foramen;
5. An elongated ilial process, more so than other teleosauroids (e.g. *Charitomenosuchus* NHMUK PV R 3806);
6. A sub-triangular ischial blade; and
7. Reduced dorsal ornamentation on osteoderms, with large, shallow, well spaced pits.

Bathysuchus megarhinus (Hulke, 1871) Foffa et al., 2019

(Fig. 46-47)

Age: *Aulacostephanus autissiodorensis* Sub-Boreal ammonite Zone, Upper Kimmeridgian, Upper Jurassic.

Locality: Kimmeridge, Dorset, UK.

Stratigraphic horizon: Dorset succession, lower Kimmeridge Clay Formation, Ancholme Group.

Holotype: NHMUK PV OR 43086, a partial rostrum.

Referred material: DORCM G.05067i-v (premaxillae, isolated tooth and partial osteoderm), LPP unnumbered specimen (a partial rostrum, mandible and skull).

Scoring sources: The holotype (NHMUK PV OR 43086) and the unnumbered LPP specimen were studied first-hand. D. Foffa provided high quality photographs of DORCM G.05067i-v, and *B. megarhinus* was also discussed at great length with D. Foffa.

Autapomorphic characters: shallow, minor ornamentation on the parietal (nearly imperceptable); considerably pronounced lateral expansion of the premaxilla with rounded, straightened lateral margins; in the mandible, the fifth dentary alveolar pair is posterolaterally oriented and on the posterior end of the mandibular spatula (rather than posterior to the mandibular spatula).

Emended diagnosis: longirostrine snout; rostrum narrows immediately anterior to the orbits (shared with *Mycterosuchus*, *I. potamosiamensis*, *Teleosaurus*, *Sericodon* and *Aeolodon*); shallow, inconspicuous ornamentation of the premaxillae and maxillae (similar to the Chinese teleosauroid, *Indosinosuchus*, *Sericodon* and *Aeolodon*); no ornamentation on the prefrontal (shared with *Plagiophthalmosuchus*, *I. potamosiamensis*, *Sericodon* and *Aeolodon*); external nares are '8' shaped in dorsal view (shared with *Mystriosaurus*, the Chinese teleosauroid, *I. potamosiamensis*, *Mycterosuchus* and *Aeolodon*) and in anterior view (shared with *Mystriosaurus*, the Chinese teleosauroid, *I. potamosiamensis* and *Aeolodon*); external nares are anterodorsally oriented (shared with *Mystriosaurus*, the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Mycterosuchus*, *Bathysuchus* and *Sericodon*); reduced anteroposterior length of the external nares; more than 67% of the premaxillae total length is posterior to the external nares (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *I. potamosiamensis*, *Mycterosuchus*, *Sericodon* and *Aeolodon*); premaxillary anterior and posterior medial margin of external nares formed by two bulbous projections (shared with *Mycterosuchus*); the anterior and anterolateral margins of the premaxillae are strongly anteroventrally deflected and extend ventrally (shared with *Mystriosaurus*, the Chinese teleosauroid, *Mycterosuchus* and *Platysuchus*); inconspicuously ornamented maxillary dorsal surface (shared with the Chinese teleosauroid and *Aeolodon*), consisting of a shallow irregular pattern of ridges and anastomosing grooves; nasal, prefrontal, lacrimal are also inconspicuously ornamented; absence/extremely reduced frontal ornamentation (shared with *Aeolodon*); the rostrum narrows markedly immediately anterior to the orbits (shared with *Teleosaurus* and *Mycterosuchus*); frontal width is broader than the orbital width (shared with *Plagiophthalmosuchus*, *Mystriosaurus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Aeolodon*, 'S.' cf. *bouchardi*, *Neosteneosaurus*,

Mac. buffetauti and *Mac. mosae*); palatine anterior margin terminates distal to the 20th maxillary alveoli (shared with *Mycterosuchus*); basioccipital tubera reduced (shared with *Plagiophthalmosuchus*, *Mycterosuchus* and *Sericodon*); mandibular symphysis over 50% of mandible length (shared with *Mycterosuchus*, *Aeolodon*, *Macrospondylus*, *Seldsienean* and *Charitomenosuchus*); premaxillae with five alveoli (shared with *Platysuchus*, *Teleosaurus* and *Sericodon*); the P1-P2 do not form a couplet (shared with *Platysuchus*, *Mycterosuchus* and *Sericodon*); the P3-P4 do not form a couple (shared with the Chinese teleosauroid); the P1 and P2 alveoli are lateral to each other at the anterior margin of the premaxilla (shared with *Mycterosuchus*, *Sericodon* and possibly *Aeolodon*); the P3 and P4 are aligned on the lateral plane of the external margin more so than P2 (shared with *Sericodon*); the P1 and P2 are on the same transverse plane, and the lateral margin between the P2 and P3 is subrectangular (shared with *Mycterosuchus*, *Sericodon* and *Aeolodon*); anterior maxillary interalveolar spacing is sub-equal to longer than adjacent alveoli; lack of apical tooth carinae (shared with *Sericodon*); the pits on the dorsal osteoderms are circular and regularly organised in alternate rows (similar with *Aeolodon*); dorsal osteoderms reduced in size and thickness (shared with *Aeolodon*).

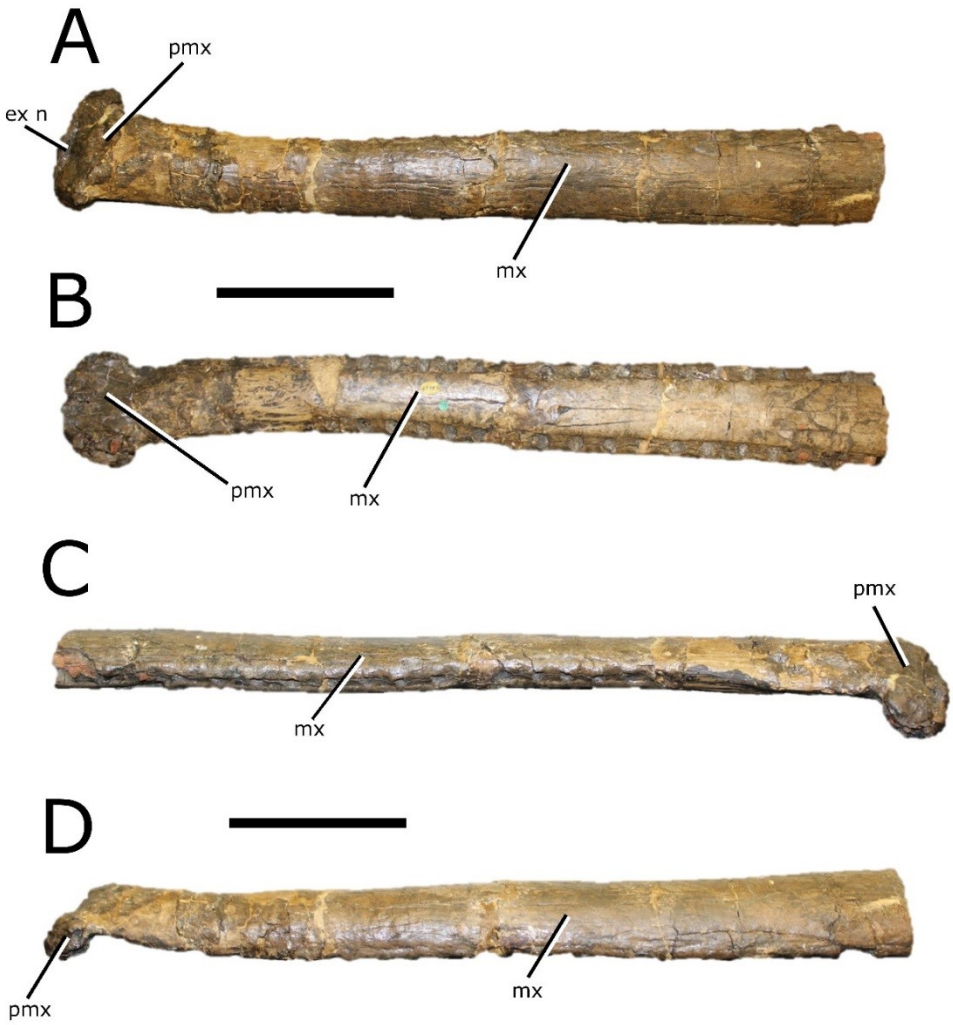


Figure 46. *Bathysuchus megarhinus* (Hulke, 1871) Foffa et al., 2019, NHMUK PV OR 43086, holotype. Partial rostrum in (A) dorsal, (B) ventral, (C) right lateral and (D) left lateral views. Refer to abbreviations list. Scale bars: 10 cm.

Remarks: '*Steneosaurus*' *megarhinus* was initially named and described by Hulke (1871), and recently redescribed and renamed as *Bathysuchus* by Foffa et al. (2019). Due to similar anatomical features of the cranium, stratigraphic horizons, and comparative measurements of the humerus and femur with *Aeolodon*, Foffa et al (2019) concluded that these two genera were evidence of the first deep water, more pelagic teleosauroids.

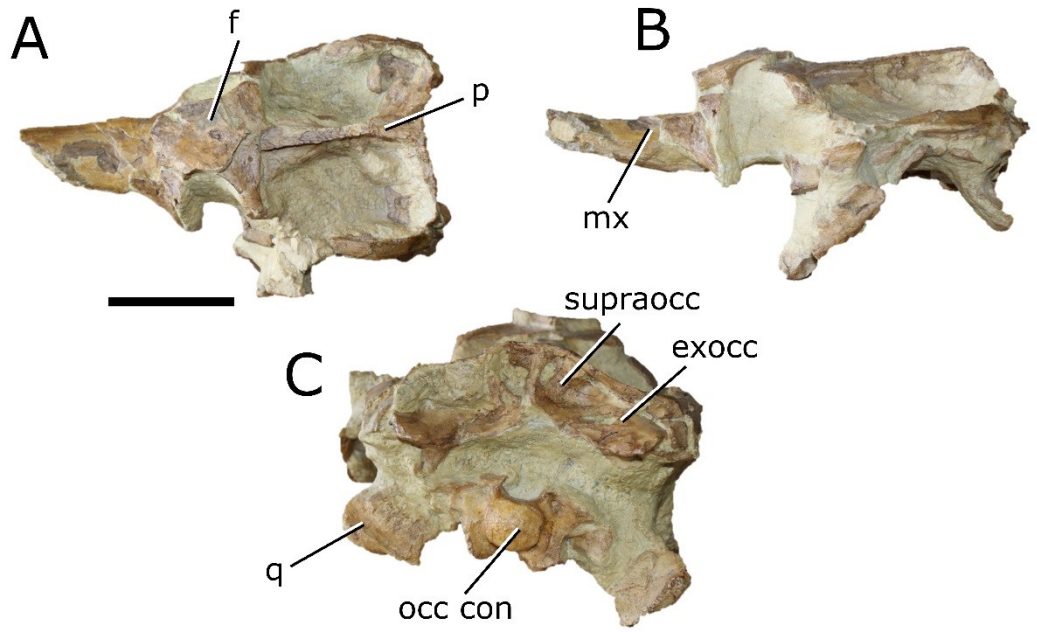


Figure 47. *Bathysuchus megarhinus* (Hulke, 1871) Foffa et al., 2019, referred unnumbered LPP specimen. Partial skull in (A) dorsal, (B) left lateral and (C) occipital views. Refer to abbreviations list. Scale bar: 10 cm.

Sericodon jugleri von Meyer, 1845

(Fig. 48)

Age: Late Kimmeridgian to Early Tithonian, Upper Jurassic.

Localities: Courtedoux-Bois de Sylleux, Courtedoux-sur Combe Ronde, Courtedoux-Tchâfouè and Courtedoux-Vâ Tche Tchâ, northwestern Switzerland; Hannover, Germany.

Stratigraphic horizons: Reuchenette Formation.

Holotype: Isolated teeth from Hannover (Germany) and Solothurn (Switzerland). Catalogue numbers currently unknown.

Referred material: BSY006-348, BSY007-134, BSY008-622, SCR010-312, SCR010-1184, SCR011-2460, SCR011-406, TCH005-151 TCH007-215, VTT006-171 (see Schaefer, et al., 2018), as well as LM 16645-46 (anterior mandible), NHMUK PV R 1752, NRM-PZ R2337, SMF R 431a-b, SMF R 4318 (isolated teeth), unnumbered Göttingen specimen (partial skull).

Scoring sources: All relevant material was scored using Schaefer, et al. (2018). Additional specimens (LM 16645-46, NHMUK PV R 1752, NRM-PZ R2337, SMF R 431a-b, SMF R 4318, unnumbered Göttingen specimen) were examined first-hand.

Autapomorphic characters: unornamented intertemporal bar; external nares slightly subcircular in dorsal view; palatal canals extremely shallow; lack of apical enamel ridges; tuberculum and articular facet of dorsal rib situated close to the lateromedial edge; posteromedial tuber of femur reduced.

Emended diagnosis: longirostrine snout; rostrum narrows immediately anterior to orbits (shared with *I. potamosiamensis*, *Teleosaurus*, *Bathysuchus*, *Mycterosuchus* and *Aeolodon*); no conspicuous ornamentation on both the prefrontal (shared with *Plagiophthalmosuchus*, *I. potamosiamensis*, *Bathysuchus* and *Aeolodon*) and lacrimal (shared with *Plagiophthalmosuchus*, *I. potamosiamensis*, *Aeolodon* and *Macrospondylus*); frontal ornamentation restricted to centre (shared with *Aeolodon*, *Charitomenosuchus*, *Seldsienean*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); external nares oriented anterodorsally (shared with *Mystriosaurus*, the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Mycterosuchus* and *Bathysuchus*); over 67% of premaxilla total length is posterior to the external nares (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *I. potamosiamensis*, *Mycterosuchus*, *Bathysuchus* and *Aeolodon*); anteromedial projection of the frontal is relatively broad but becomes immediately mediolaterally thin at the anterior-most part (shared with *Teleosaurus*); basioccipital tubera reduced (shared with *Plagiophthalmosuchus*, *Mycterosuchus* and *Bathysuchus*); five premaxillary alveolar pairs (shared with *Platysuchus*, *Teleosaurus* and *Bathysuchus*); the P1 and P2 alveoli are lateral to each other at the anterior margin of the premaxilla (shared with *Mycterosuchus*, *Bathysuchus* and possibly *Aeolodon*); the P3 and P4 are aligned on the lateral plane of the external margin more so than P2 (shared with *Bathysuchus*); the P1 and P2 are on the same transverse plane, and the lateral margin between the P2 and P3 is subrectangular (shared with *Mycterosuchus*, *Bathysuchus* and

Aeolodon); lack of apical carinae (shared with *Bathysuchus*) shallow tuberculum (shared with *Aeolodon*, *Macrospondylus* and *Charitomenosuchus*); postacetabular iliac process elongated (shared with *Plagiophthalmosuchus*, *Platysuchus*, *Teleosaurus* and *Macrospondylus*); dorsal osteoderm pits are subcircular and organised in sub-parallel rows.

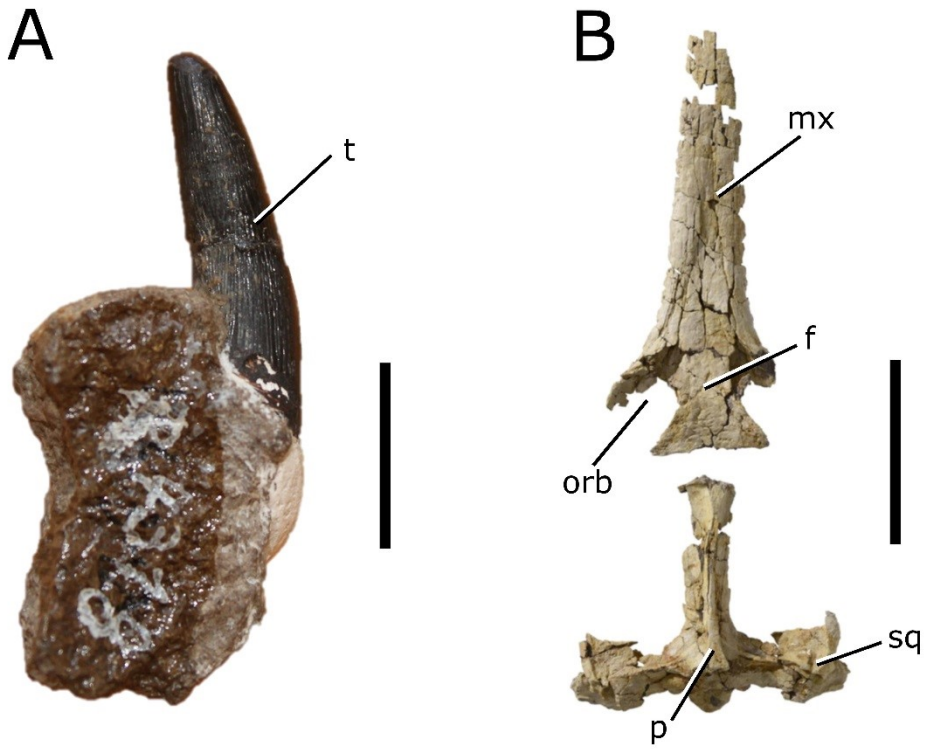


Figure 48. *Sericodon jugleri* von Meyer, 1845, referred specimens. (A) Tooth in lingual view (SMF R 4318) and (B) partial skull in dorsal view (SCR010-312 in Schaefer et al., 2018). Refer to abbreviations list. Scale bars: 1 cm (A) and 10 cm (B).

Remarks: *Sericodon* was initially diagnosed by von Meyer (1845) but since the late 1800s has been considered a junior synonym of '*Steneosaurus*' (Sauvage, 1896; Sauvage, 1897-98; von Huene, 1926; Kuhn, 1936; Steel, 1973; Buffetaut et al., 1985). *Sericodon* differs from *Bathysuchus* in the following characteristics:

1. *Sericodon* (TCH005-151; Schaefer et al., 2018) lacks enamel ridges on the apices of the dentition, whereas *Bathysuchus* possesses faint but present enamel ridges (DORCM G.05067iv);
2. The lateral margins of the premaxillae are more expanded and sub-rectangular in *Bathysuchus* (NHMUK PV OR 43086; unnumbered LPP specimen). In *Sericodon* (SCR011-406;

Schaefer et al., 2018) they are less laterally expaned with more rounded margins;

3. Frontal ornamentation is present in *Sericodon* (SCR010-312; Schaefer et al., 2018) but is absent in *Bathysuchus* (unnumbered LPP specimen) (in specimens of approximately equal size);
4. A distinct groove between the two distinct quadrate condyles is present in *Sericodon* (SCR010-312; Schaefer et al., 2018), whereas in *Bathysuchus* (unnumbered LPP specimen) the groove is nearly non-existent (although this may be due to preservation);
5. The P3 alveoli is substantially larger than both the P1 and P2 in *Sericodon* (SCR011-406; Schaefer et al., 2018). In *Bathysuchus* (DORCM G.05067i), the P3 is relatively the same size as the P2 and slightly larger than the P1; and
6. *Sericodon* and *Bathysuchus* are always found to be stable sister taxa in the phylogeny (see below), regardless of teleosauroid species and/or characters added or removed.

Indosinosuchus potamosiamensis Martin et al., 2019

(Fig. 49)

Age: Late Jurassic (exact age is unknown, hypothesised to be Tithonian).

Locality: Pho Noi, Phu Phan range, Kham Muang District, Kalasin Province, northeastern Thailand.

Stratigraphic horizon: lower part of the Phu Kradung Formation, Khorat Group.

Holotype: PRC-11, a complete skull and mandible.

Scoring sources: The holotype (PRC-11) was examined first-hand. Additional information was examined in Martin et al. (2019).

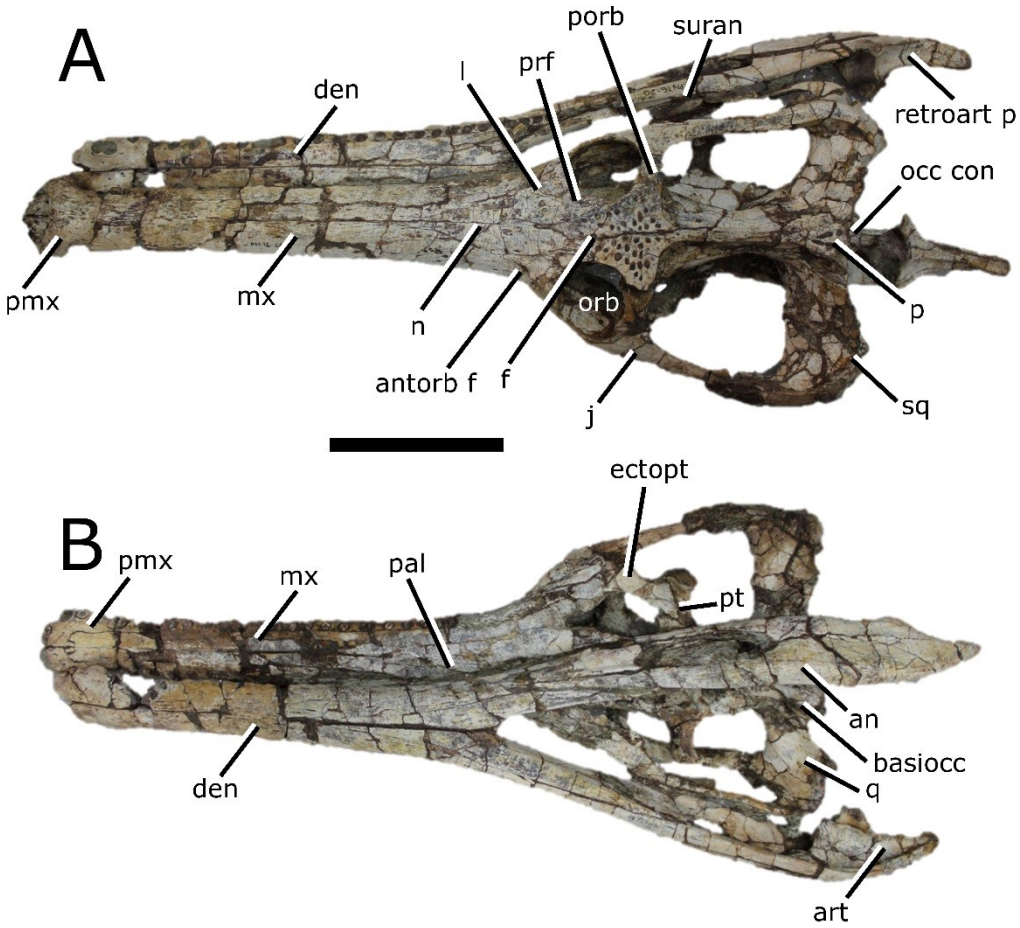


Figure 49. *Indosinosuchus potamosiamensis* Martin et al., 2019, PRC-11, holotype. Skull and attached mandible in (A) dorsal and (B) ventral (palatal) views. Refer to abbreviations list. Scale bar: 10 cm.

Autapomorphic characters: extremely anteroposteriorly elongated posterior nasal processes; substantially elongated and mediolaterally thin anterior process of the nasal; the D2–D3 interalveolar space is longer than that between the D1 and D2*.

Emended diagnosis: mesorostrine snout; tooth row and quadrate condyle unaligned with quadrate at a lower level, and both below the occipital condyle (shared with *Indosinosuchus* sp. and *Mycterosuchus*); tooth row at a lower level than occipital condyle (shared with *Plagiophthalmosuchus*, *Indosinosuchus* sp., *Platysuchus*, *Teleosaurus*, *Mycterosuchus* and *Macrospondylus*); rostrum narrows immediately anterior to orbits (shared with *Teleosaurus*, *Mycterosuchus*, *Aeolodon*, *Bathysuchus* and *Sericodon*); shallow, irregular maxillary ornamentation consisting of grooves (similar to

the Chinese teleosauroid, *Bathysuchus* and *Aeolodon*); no conspicuous ornamentation on both the prefrontal and lacrimal (similar to *Plagiophthalmosuchus*, *Aeolodon* and *Sericodon*); frontal ornamentation extends from the centre to lateral- and anterior-most regions (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Indosinosuchus* sp., *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Macrospondylus* and *Clovesuurdameredeor*); external nares oriented anterodorsally (shared with *Mystriosaurus*, the Chinese teleosauroid, *Indosinosuchus* sp., *Platysuchus*, *Mycterosuchus*, *Bathysuchus* and *Sericodon*); over 67% of premaxilla total length is posterior to the external nares (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Mycterosuchus*, *Bathysuchus*, *Sericodon* and *Aeolodon*); presence of small, oval-shaped antorbital fenestrae; anterior margin of the supratemporal fossae are noticeably inclined anterolaterally (shared with *Mystriosaurus*, the Chinese teleosauroid, *Indosinosuchus* sp., *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus* and *Aeolodon*); frontal width narrower than orbital width (shared with *Charitomenosuchus*); dorsal margins of orbits upturned (shared with *Teleosaurus*, *Mycterosuchus* and *Aeolodon*); postorbital reaches the orbit posteroventral margin and forms an extensive area of the orbit ventral margin (shared with *Mystriosaurus*, the Chinese teleosauroid, *Platysuchus*, *Teleosaurus* and *Mycterosuchus*); palatine anterior margin terminates level to 17th or 18th maxillary alveoli (similar to *Charitomenosuchus* and *Mac. buffetauti*); symphysis under half of mandible length, between 0.45 and 0.5 (shared with *Mystriosaurus*, *Deslongchampsina* and *Proexochokefalos*); mandibular fenestra anteroposteriorly small and poorly elliptic (similar to *Mystriosaurus*); at least 27 maxillary alveolar pairs; third premaxillary alveolus are enlarged relative to adjacent alveoli (shared with the Chinese teleosauroid); at least 30 dentary alveoli.

Indosinosuchus sp.

(Fig. 50)

Age: Late Jurassic (exact age is unknown, hypothesised to be Tithonian).

Locality: Pho Noi, Phu Phan range, Kham Muang District, Kalasin Province, northeastern Thailand.

Stratigraphic horizon: lower part of the Phu Kradung Formation, Khorat Group.

Referred material: PRC-239, a nearly complete skull and mandible.

Scoring Sources: PRC-239 was examined first-hand.

Autapomorphic characters: approximately 64% of premaxilla total length is posterior to the external nares; anteroposteriorly thickened postorbital bar.

Emended diagnosis: mesorostrine snout; tooth row and quadrate condyle unaligned with quadrate at a lower level, and both below the occipital condyle (shared with *I. potamosiamensis* and *Mycterosuchus*); tooth row at a lower level than occipital condyle (shared with *Plagiophthalmosuchus*, *I. potamosiamensis*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus* and *Macrospondylus*); premaxilla and maxilla ornamented with shallow ridges (similar to the Chinese teleosauroid, *I. potamosiamensis*, *Bathysuchus*, *Sericodon* and *Aeolodon*); frontal ornamentation extends from the centre to lateral- and anterior-most regions (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *I. potamosiamensis*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Macrospondylus* and *Clovesuurdameredeor*); enlarged premaxillary foramina lateral to the external nares (similar to *Mystriosaurus* and *Yvridiosuchus*); external nares oriented anterodorsally (shared with *Mystriosaurus*, the Chinese teleosauroid, *I. potamosiamensis*, *Platysuchus*, *Mycterosuchus*, *Bathysuchus* and *Sericodon*); dorsoventrally deep premaxilla (similar to *Mystriosaurus*); the anterior and anterolateral premaxillary margins are orientated anteroventrally and extend ventrally (shared with *Mystriosaurus*, the Chinese teleosauroid, *I. potamosiamensis*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus* and *Aeolodon*); anterior margin of the supratemporal fossae are noticeably inclined anterolaterally (shared with the Chinese teleosauroid, *I. potamosiamensis*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus* and *Aeolodon*); frontal width subequal to orbital width (shared with the Chinese teleosauroid, *Macrospondylus*,

Clovesuurdameredeor, *Seldsienean*, *Yvridiosuchus*, *Deslongchampsina*, *Proexochokefalos*, *Mac. hugii* and *Mac. rex*); large, slightly robust teeth with a pointed apex (similar to *Mystriosaurus*).

Remarks: Martin et al. (2019) initially diagnose PRC-239 as *Indosinosuchus potamosiamensis*; however, I currently designate PRC-239 as *Indosinosuchus* sp., as it differentiates from the holotype (PRC-11) of *I. potamosiamensis* in several features:

1. Rostrum does not narrow immediately anterior to the orbits;
2. External nares 'B'-shaped in anterior view;
3. Premaxillary length posterior to the external nares is between 50-65%;
4. Frontal width subequal to orbital width;
5. Dorsal margin of the orbit flush with the skull dorsal surface; and
6. Elliptic external mandibular fenestra.

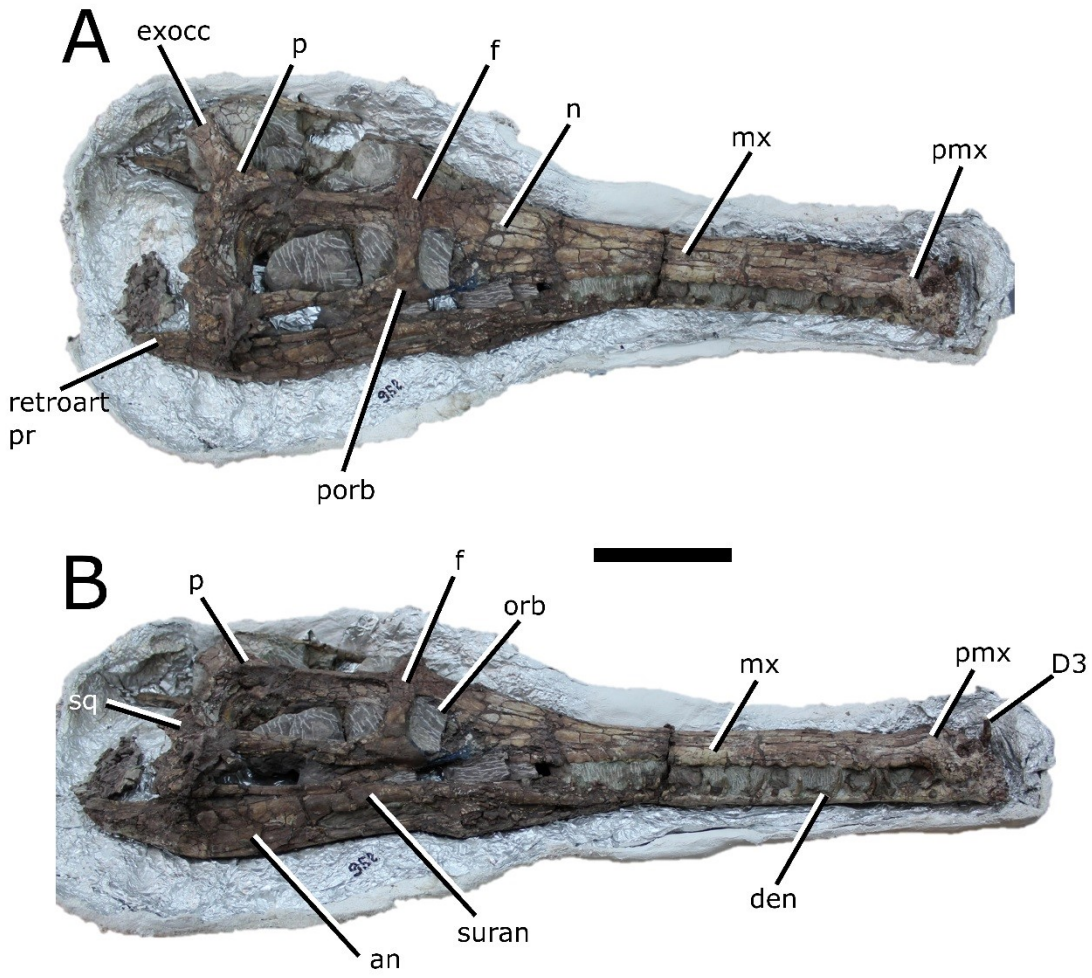


Figure 50. *Indosinosuchus* sp. (labelled as *I. potamosiamensis* in Martin et al., 2019), PRC-239. Skull and mandible in (A) dorsal and (B) right lateral views. Refer to abbreviations list. Scale bar: 10 cm.

Macrospondylus bollensis von Jäeger, 1828

(Fig. 51-52)

Age: Lower Toarcian, Lower Jurassic.

Localities: Baden-Württemberg, Germany; Yorkshire, UK; Sanem, Luxembourg.

Stratigraphic horizons: Posidonia Shale Formation; Whitby Mudstone Formation; *Harpoceras serpentinum* ammonite Zone (‘schistes bitumineux’).

Holotype: MMG BwJ 595, a partial postcranial skeleton, including dorsal, sacral and anterior caudal vertebrae, femora, one tibia, one fibula, one pes and disarticulated osteoderms.

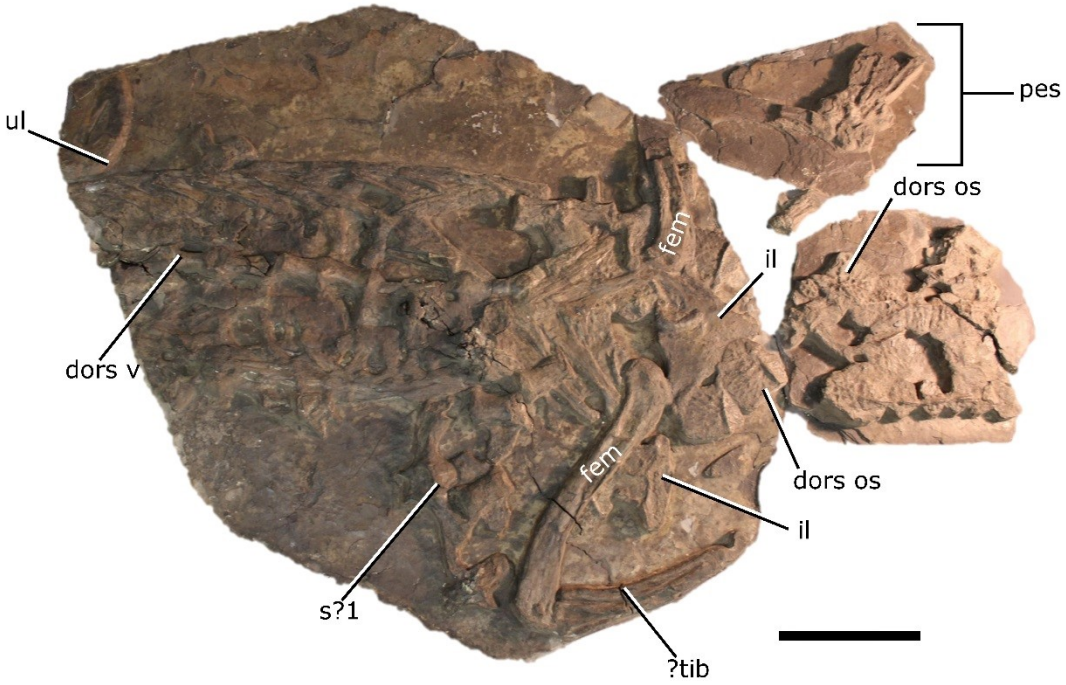


Figure 51. *Macrospondylus bollensis* von Jäeger, 1828, MMG BwJ 595, holotype. Partial postcranial skeleton. Refer to abbreviations list. Scale bar: 10 cm.

Referred material: GPIT-RE-9427; MMG BwJ 689; NHMUK PV R 324; NHMUK PV R 756; NHMUK PV R 1088; NHMUK PV R 5703; NHMUK PV OR 14436; NHMUK PV OR 14438; NHMW-1882-0026-4082; PMU R161; SMNS 849; SMNS 9427; SMNS 9428; SMNS 17484; SMNS 20280; SMNS 20283; SMNS 51555; SMNS 51563; SMNS 51753; SMNS 51957; SMNS 51984; SMNS 53422; SMNS 10 000 (all representing complete or near-complete skeletons); unnumbered OUMNH partial skull.

Scoring sources: The holotype (MMG BwJ 595), as well as a multitude of specimens from Germany, England and Luxembourg were studied first-hand. Additional photographs were provided by B. Kear (PMU), M. Manabe (NMNSJ), U. Menkveld-Gfeller (NMBE), J. Nurnberg (Museum Kloster Banz), L. Schöllmann (LWL), A. Sennikov (PIN), W. Simpson (FMNH) and G. Wahlefeld (NMR).

Autapomorphic characters: the proximal region of the humerus is strongly proximodistally elongated and weakly posteriorly hooked; ulna with well-developed distal curvature.

Emended diagnosis: longirostrine skull; tooth row at a lower level than the quadrate (shared with *Plagiophthalmosuchus*, *Platysuchus*, *Indosinosuchus*, *Teleosaurus* and *Mycterosuchus*); no conspicuous ornamentation on the lacrimal (shared with *Plagiophthalmosuchus*, *I. potamosiamensis*, *Bathysuchus*, *Aeolodon* and *Charitomenosuchus*); frontal ornamentation extends from the centre to lateral- and anterior-most regions (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Indosinosuchus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus* and *Clovesuurdameredeor*); external nares oriented dorsally (shared with *Plagiophthalmosuchus*, *Sericodon*, *Charitomenosuchus*, *Proexochokefalos*, *Deslongchampsina*, *Neosteneosaurus* and Machimosaurini); presence of shallow, slightly anteroposteriorly elongated antorbital fenestrae; no anterolateral expansion or inclination of the supratemporal fenestrae (shared with *Plagiophthalmosuchus*, *Clovesuurdameredeor*, *Charitomenosuchus*, *Seldsienean*, *Deslongchampsina*, *Proexochokefalos*, *Pr*. cf. *bouchardi*, *Neosteneosaurus* and Machimosaurini); frontal width subequal to orbital width (shared with the Chinese teleosauroid, *Indosinosuchus* sp., *Clovesuurdameredeor*, *Seldsienean*, *Deslongchampsina*, *Proexochokefalos*, *Yvridiosuchus*, *Mac. hugii* and *Mac. rex*); orbit is longitudinal ellipsoid in shape (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Platysuchus*, *Aeolodon*, *Charitomenosuchus*, *Seldsienean*, *Pr*. cf. *bouchardi*, *Proexochokefalos*, *Deslongchampsina* and *Neosteneosaurus*); basisphenoid exposed along the palatal surface, bifurcating the pterygoids (shared with *Charitomenosuchus*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus*, *Yvridiosuchus* and *Lemmysuchus*); mandibular symphysis over 50% of mandible length (shared with *Mycterosuchus*, *Bathysuchus*, *Aeolodon*, *Seldsienean* and *Charitomenosuchus*); anterior maxillary teeth procumbent (shared with *Indosinosuchus*, *Platysuchus*, *Teleosaurus*, *Sericodon*, *Aeolodon* and *Charitomenosuchus*); tuberculum of dorsal rib situated on the medial edge (shared with *Platysuchus*, *Aeolodon* and *Lemmysuchus*); shallow tuberculum on the dorsal ribs (shared with

Sericodon, *Aeolodon* and *Charitomenosuchus*); forelimb shorter than hindlimb by approximately 22-23% (similar to *Platysuchus*); tibia shorter than the femur by approximately 25% (similar to *Platysuchus*); femoral condyles are relatively the same size (shared with *Platysuchus*, *Aeolodon* and *Lemmysuchus*).

Figure 52. Additional complete and near-complete specimens of *Macrospondylus bollensis* von Jäeger, 1828: (A) SMNS 51563; (B) SMNS 51984; and (C) SMNS 59736.

Remarks: The holotype of *Macrospondylus bollensis* (MMG BwJ 595) was one of the first well preserved vertebrate fossils housed in a scientific institution. It was acquired at the beginning of the 18th century by Johann Georg Gmelin, a chemist and pharmacist, for the Royal Churfurstliche Naturaliengalerie Dresden, and was described by the zoologist Georges Cuvier in 1812 as the iconic "*Gavial de Boll*". The specimen was badly burned in the Zwinger fire of May 1849 (during the "*Burgerliche* revolution"), but managed to survive. Because of this damage to the holotype, the idea has been expressed that it cannot be referable to other *Macrospondylus* specimens. However, MMG BwJ 595 displays a combination of postcranial features that are unique to *Macrospondylus* (e.g. SMNS 18672; SMNS 51563; SMNS 51753; SMNS 51957):

1. Large, anteroposteriorly elongated and dorsoventrally thin cervical ribs (most posteriorly placed);
2. Shallow tuberculum on dorsal ribs;
3. Ulna with well-developed, pronounced distal curvature that is noticeably larger than the distal part;
4. Anteroposteriorly short anterior iliac process;
5. Femoral condyles of relatively same size; and

6. Dorsal osteoderms with a pronounced keel and subcircular, numerous, separated pits.

Gen. nov.

Seldsienean megistorhynchus (Eudes-Deslongchamps, 1866a)

(Fig. 53)

Type species: *Steneosaurus megistorhynchus* Eudes-Deslongchamps, 1866a. Now referred to as *Seldsienean megistorhynchus* (Eudes-Deslongchamps, 1866a) **comb. nov.**

Etymology: 'Rare one'. *Seldsīene* is Old English for 'rare' or 'seldom seen', and '*-an*' is Old English for 'one'. Refers to the rarity of this taxon compared to other Bathonian teleosauroids.

Age: Bathonian, Middle Jurassic.

Localities: unspecified location in France; Enslow Bridge, Oxfordshire, UK.

Stratigraphic horizons: '*Calcaire de Caen*'; Cornbrash Formation, Great Oolite Group.

Holotype: Cranial fragments initially described by Cuvier (1824), re-described by Eudes-Deslongchamps (1866a; 1867-69), and destroyed in 1944.

Referred material: LPP.T.1 (partial mandible); OUMNH J.1414 (near-complete mandible).

Scoring Sources: The referred specimens (LPP.T.1 and OUMNH J.1415) were studied first-hand. Additional information was taken from Eudes-Deslongchamps (1866a; 1867-69).

Emended diagnosis: longirostrine skull; frontal ornamentation restricted to centre (shared with *Sericodon*, *Aeolodon*, *Charitomenosuchus*,

Deslongchampsina, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); no anterolateral expansion or inclination of the supratemporal fenestrae (shared with *Plagiophthalmosuchus*, *Clovesuurdameredeor*, *Macrospondylus*, *Charitomenosuchus*, *Deslongchampsina*, *Proexochokefalos*, *Pr*. cf. *bouchardi*, *Neosteneosaurus* and Machimosaurini); frontal width subequal to orbital width (shared with the Chinese teleosauroid, *Indosinosuchus* sp., *Clovesuurdameredeor*, *Macrospondylus*, *Deslongchampsina*, *Proexochokefalos*, *Yvridiosuchus*, *Mac. hugii* and *Mac. rex*); orbit is longitudinal ellipsoid in shape (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Platysuchus*, *Aeolodon*, *Macrospondylus*, *Charitomenosuchus*, *Pr*. cf. *bouchardi*, *Proexochokefalos*, *Deslongchampsina* and *Neosteneosaurus*); mandibular symphysis over 50% of mandible length (shared with *Mycterosuchus*, *Bathysuchus*, *Aeolodon*, *Macrospondylus* and *Charitomenosuchus*); over 30 dentary alveoli per side (shared with *Plagiophthalmosuchus*, *Platysuchus*, *Bathysuchus*, *Mycterosuchus* and *Charitomenosuchus*).

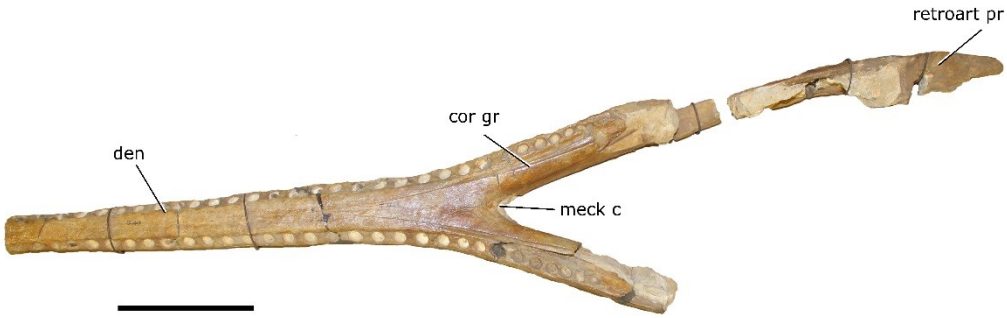


Figure 53. *Seldsienean megistorhynchus* (Eudes-Deslongchamps, 1866a), **comb. nov.**, OUMNH J.1414, referred specimen. Refer to abbreviations list. Scale bar: 10 cm.

Gen. nov.

Charitomenosuchus leedsi (Andrews, 1909)

(Fig. 54-55)

Type species: *Steneosaurus leedsi* Andrews, 1909. Now referred to as *Charitomenosuchus leedsi* (Andrews, 1909), **comb. nov.**

Etymology: 'Graceful crocodile'. *Charitoménos* (χαριτωμένος) is Greek for 'graceful' (referring to the slender, elegant skull of this taxon) and *suchus* is the Latinized form of the Greek *soukhos* (σοῦχος), meaning crocodile.

Age: Middle Callovian, Middle Jurassic.

Locality: Peterborough, UK.

Stratigraphic horizon: Peterborough Member, Oxford Clay Formation, Ancholme Group.

Holotype: NHMUK PV R 3320, a nearly complete skull.

Referred material: BRLSI GP1770a-e (a complete skull and mandible); NHMUK PV R 2619 (a complete mandible and additional femora, ilia, ischia, pubes, tibiae, humeri, ulnae, radiae, ribs [cervical, dorsal], partially preserved vertebrae [two cervical, two dorsal, two sacral] and dorsal osteoderms); NHMUK PV R 3806 (a nearly complete skeleton); PETMG R179 (complete skull).

Scoring Sources: The holotype (NHMUK PV R 3320) as well as all referred specimens mentioned above were examined first-hand.

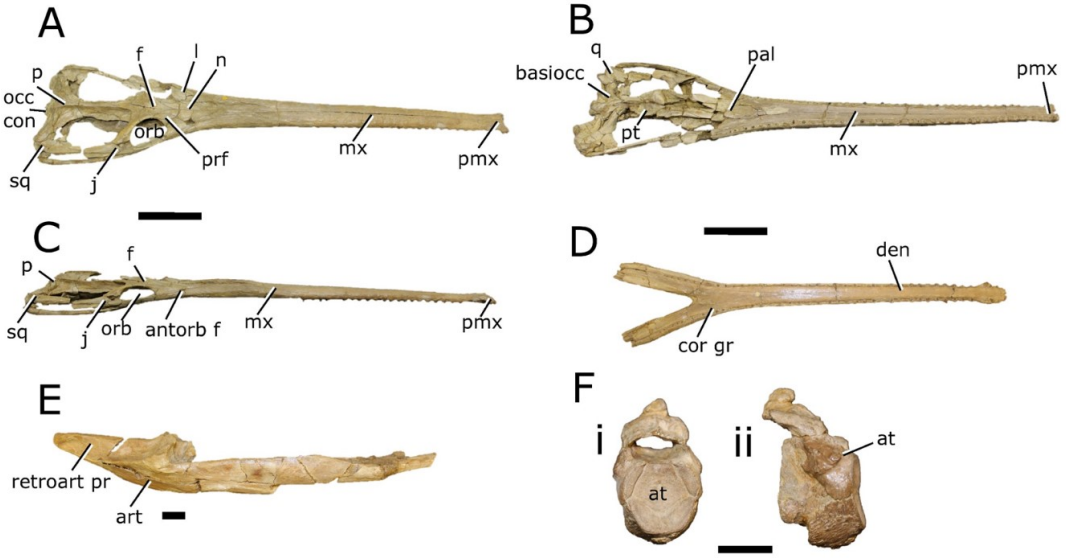


Figure 54. *Charitomenosuchus leedsi* (Andrews, 1913), **comb. nov.**, NHMUK PV R 3320, holotype. Skull in (A) dorsal, (B) ventral (palatal) and (C) right lateral views; partial mandible in (D) dorsal view. (E) Posterior section of the mandible in right lateral view; (F) atlas in (i) anterior and (ii) right lateral view. Refer to abbreviations list. Scale bars: 10 cm (A-D) and 2 cm (E-F).

Autapomorphic characters: frontal ornamentation consists of circular, spaced apart pits limited to the centre-most and posterior frontal; strongly interdigitating premaxilla-maxilla suture; narrow mediolateral supratemporal fenestra width (relative to other teleosauroids); supratemporal arch dorsal margin subtly concave in lateral view; neural spine height of anterior thoracic vertebrae is less than centrum height; dorsal osteoderms with large, subcircular well-spaced pits arranged in a semi-parallel pattern; mediolaterally thickened keel on sacral osteoderms.

Emended diagnosis: longirostrine, gracile skull; tooth row and occipital condyle aligned, and quadrate condyle at a lower level (shared with the Chinese teleosauroid, *Proexochokefalos*, *Pr*. cf. *bouchardi*, *Neosteneosaurus* and Machimosaurini); skull width less than 26% of skull length (shared with *Plagiophthalmosuchus*, *Mycterosuchus*, *Bathysuchus* and *Aeolodon*); no ornamentation on the lacrimal (shared with *Plagiophthalmosuchus*, *I. potamosiamensis*, *Aeolodon* and *Macrospondylus*); external nares oriented dorsally (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); premaxillary anterior and anterolateral margins are not sub-vertical (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Andrianavoay*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); frontal width narrower than orbital width (shared with *I. potamosiamensis*); orbit is longitudinal ellipsoid in shape (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Platysuchus*, *Aeolodon*, *Macrospondylus*, *Seldsienean*, *Pr*. cf. *bouchardi*, *Proexochokefalos*, *Deslongchampsina* and *Neosteneosaurus*); the anterior process of the jugal is slender, elongated and extends anteriorly (shared with *Clovesuurdameredeor*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); palatine anterior margin terminates level to 15th to 19th maxillary alveoli (shared with *I. potamosiamensis* and *Mac. buffetauti*); basisphenoid exposed along the palatal surface, bifurcating the pterygoids (shared with *Macrospondylus*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus*, *Yvridiosuchus* and *Lemmysuchus*); the mandibular symphysis is over 50% of the mandible length (shared with *Bathysuchus*, *Mycterosuchus*, *Macrospondylus*, *Aeolodon* and *Seldsienean*); mandibular

symphysis depth is very narrow, approximately 4-4.5% of the mandible length (shared with *Mycterosuchus*); the P1 is oriented anteriorly whereas the P2 is oriented slightly medially (shared with *Proexochokefalos*); over 30 dentary alveoli per side (shared with *Plagiophthalmosuchus*, *Platysuchus*, *Bathysuchus*, *Mycterosuchus* and *Seldsienean*); slender teeth with weak mediolateral compression (shared with *Macrospondylus*); neural spine height of mid-cervical vertebrae is approximately equal to centrum height (similar to *Aeolodon*); the tuberculum and articular facet are situated directly in the dorsal rib (shared with *Mycterosuchus*); the dorsal rib tuberculum is shallow (shared with *Sericodon*, *Aeolodon* and *Macrospondylus*); proximal humerus strongly posteriorly deflected and hooked (similar to *Aeolodon*, *Macrospondylus* and *Neosteneosaurus*); supraacetabular iliac crest is shallow and poorly pronounced (shared with *Neosteneosaurus*, *Lemmysuchus* and *Mac. mosae*); postacetabular iliac process is fan-shaped (shared with *Neosteneosaurus*, *Lemmysuchus* and *Mac. mosae*); tibia approximately 40-50% shorter than the femur (shared with *Mycterosuchus*, *Neosteneosaurus*, *Lemmysuchus* and *Mac. mosae*); medial femoral condyle larger than lateral femoral condyle (shared with *Mycterosuchus*, *Neosteneosaurus* and *Machimosaurus*).

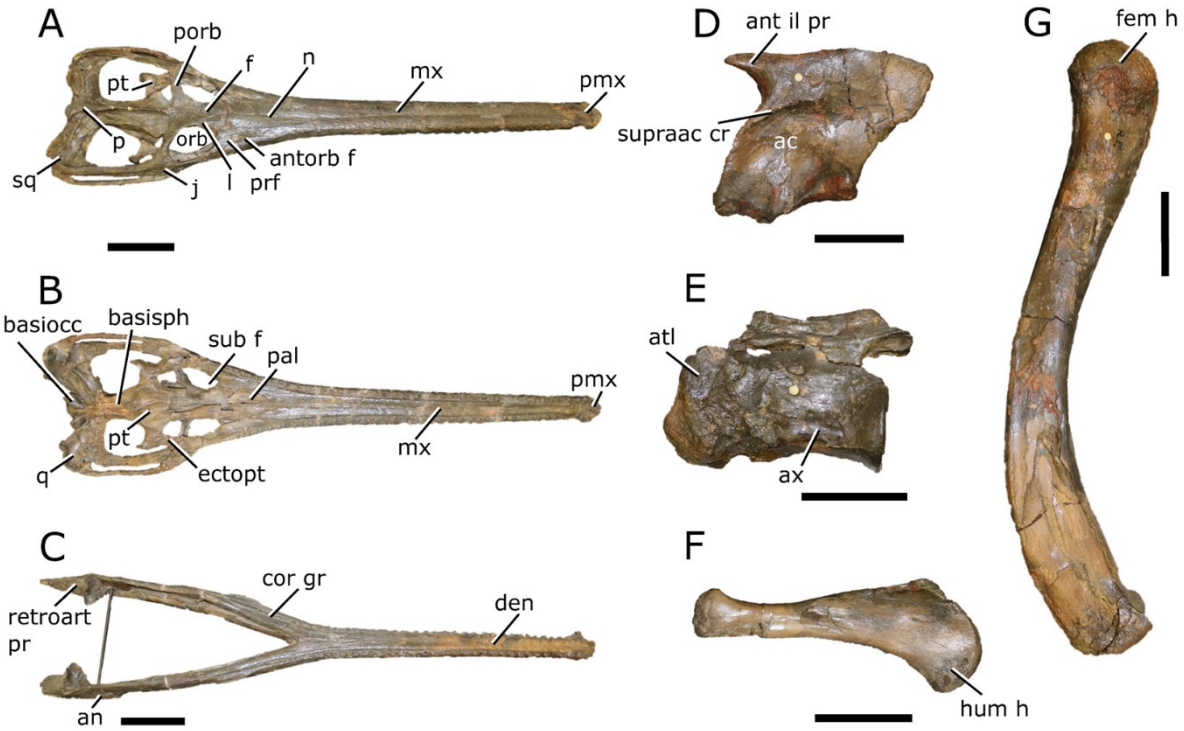


Figure 55. *Charitomenosuchus leedsi* (Andrews, 1913), **comb. nov.**, NHMUK PV R 3806, referred specimen. Skull in (A) dorsal and (B) palatal views; complete mandible in (C) dorsal view. Associated postcranial material, including: (D) left ilim in lateral view; (E) atlas-axis complex in left lateral view; (F) humerus in lateral view; and (G) right femur in lateral view. Refer to abbreviations list. Scale bars: 10 cm (A-C) and 4 cm (D-G).

Remarks: Both Vignaud (1995) and Mueller-Töwe (2006) considered *Mycterosuchus nasutus* to be a synonym of '*Steneosaurus*' *leedsi*.

Deslongchampsina larteti (Eudes-Deslongchamps, 1866a) Johnson et al., 2019

(Fig. 56)

Age: Bathonian, Middle Jurassic.

Localities: Calvados, France; Enslow Bridge, Oxfordshire, UK.

Stratigraphic horizons: '*Fuller's Earth inférieur*'; Cornbrash Formation, Great Oolite Group.

Holotype: A partial skull that was associated with a partial symphyseal section of the mandible, pelvis, hindlimb, two vertebrae and various dorsal osteoderms. Destroyed in 1944.

Neotype: OUMNH J.29851, comprising a partial skull, broken into two pieces.

Scoring Sources: The neotype (OUMNH J.29851) was studied first-hand.

Autapomorphic characters: faint constriction of the premaxillae posterior to the external nares, giving the premaxillae a rounded, 'globular' appearance; mediolaterally thin posterior processes of the nasals; gradual and well-developed anteroventral sloping of the nasals.

Emended diagnosis: mesorostrine snout; frontal ornamentation restricted to the centre (shared with *Sericodon*, *Aeolodon*, *Seldsienean*, *Charitomenosuchus*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); external nares oriented dorsally (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Charitomenosuchus*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); premaxillary anterior and anterolateral margins are not sub-vertical (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Andrianavoay*, *Charitomenosuchus*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); presence of large, anteroposteriorly elongated antorbital fenestrae, and internal antorbital fenestra over 25% of the length of the orbit (shared with *Plagiophthalmosuchus*); orbit is longitudinal ellipsoid in shape (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Platysuchus*, *Aeolodon*, *Macrospondylus*, *Charitomenosuchus*, *Seldsienean*, *Pr*. cf. *bouchardi*, *Proexochokefalos* and *Neosteneosaurus*); frontal width subequal with orbital width (shared with the Chinese teleosauroid, *Mycterosuchus*, *Proexochokefalos*, *Yvridiosuchus*, *Mac. hugii* and *Mac. rex*); small basioccipital tuberosities (similar to *Bathysuchus*); palatine anterior margin terminates distal to the 20th maxillary alveoli (shared with *Charitomenosuchus*, *Mycterosuchus* and *Bathysuchus*); mandibular symphysis slightly less than half the mandibular length, between 45 and 50% (shared with *Mystriosaurus*, *I. potamosiamensis* and *Proexochokefalos*);

deep, well-developed reception pits throughout the anterior- to mid-maxilla and gradually disappear (similar to *Mystriosaurus*, *Charitomenosuchus* and *Proexochokefalos*); large, robust, weakly-compressed teeth with a pointed apex and high relief enamel ridges (similar to *Neosteneosaurus*).

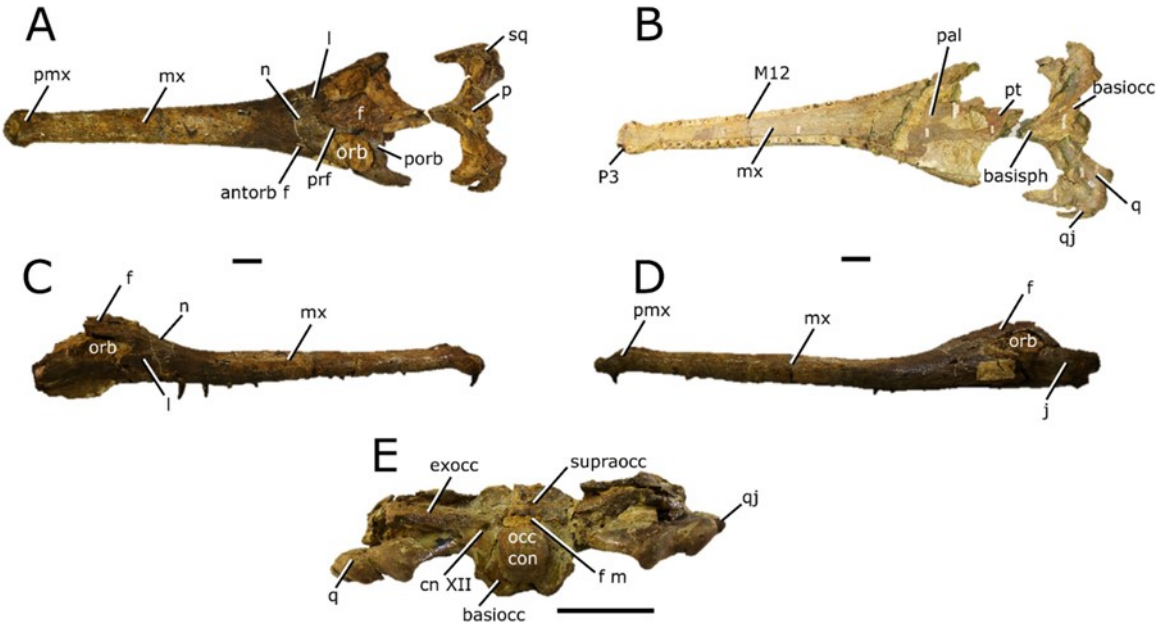


Figure 56. *Deslongchampsina larteti* (Eudes-Deslongchamps, 1866a) Johnson et al., 2019, OUMNH J.29851, neotype. Skull in (A) dorsal, (B) ventral (palatal), (C) right lateral, (D) left lateral and (E) occipital views. Refer to abbreviations list. Scale bars: 5 cm.

Gen. nov.

Proexochokefalos heberti Morel de Glasville, 1876

(Fig. 57)

Type species: *Steneosaurus heberti* Morel de Glasville, 1876. Now referred to as *Proexochokefalos heberti* (Morel de Glasville, 1876), **comb. nov.**

Etymology: 'Big tuberosities and head crocodile'. *Proexochi* (προεξοχή) is Greek for projection/tuberosity (in an anatomical sense), referring to the large occipital tuberosities that are characteristic of this taxon, and *kefálo[s]* (κεφάλι) is Greek meaning head.

Age: Upper Callovian, Middle Jurassic.

Locality: Villers-sur-mer, Calvados, France.

Stratigraphic horizon: Marnes de Dives Formation.

Holotype: MNHN.F 1890-13, a complete skull and mandible.

Scoring Sources: The holotype (MNHN.F 1890-13) was studied first-hand.

Autapomorphic characters: premaxillae dorsoventrally high in lateral view; occipital tuberosities large and well-developed; slightly mediolaterally compressed dentition with pointed apices throughout the dentary series; faint enamel ridges on apical third of dentition; 79-80° posterior curvature of the teeth throughout the entire dental series.

Emended diagnosis: mesorostrine skull; tooth row and occipital condyle aligned, and quadrate condyle at a lower level (shared with the Chinese teleosauroid, *Charitomenosuchus*, *Pr*. cf. *bouchardi*, *Neosteneosaurus* and Machimosaurini); frontal ornamentation restricted to centre (shared with *Sericodon*, *Aeolodon*, *Charitomenosuchus*, *Seldsienean*, *Deslongchampsina*, *Neosteneosaurus* and Machimosaurini); external nares oriented dorsally (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Charitomenosuchus*, *Deslongchampsina*, *Neosteneosaurus* and Machimosaurini); anterior and anterolateral margins of the supratemporal fenestrae are not sub-vertical (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Andrianavoay*, *Charitomenosuchus*, *Deslongchampsina*, *Neosteneosaurus* and Machimosaurini); flat nasals with no evidence of a midline concavity (shared with *Pr*. cf. *bouchardi*); absence of antorbital fenestrae (shared with *Neosteneosaurus* and Machimosaurini excluding *Yvridiosuchus*); supratemporal fenestra length is twice as long as the anterior width (shared with *Pr*. cf. *bouchardi* and *Neosteneosaurus*, and somewhat similar to Machimosaurini); orbit is longitudinal ellipsoid in shape (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Platysuchus*, *Aeolodon*, *Macrospondylus*, *Charitomenosuchus*, *Seldsienean*, *Pr*. cf. *bouchardi*, *Deslongchampsina* and *Neosteneosaurus*); frontal width sub-equal to orbital width (shared with the Chinese teleosauroid, *Indosinosuchus* sp.,

Macrospondylus, *Clovesuurdameredeor*, *Seldsienean*, *Deslongchampsina*, *Yvridiosuchus*, *Mac. hugii* and *Mac. rex*); anterior process of the jugal is slender and anteriorly elongated (shared with *Clovesuurdameredeor*, *Charitomenosuchus*, *Neosteneosaurus* and Machimosaurini); mandibular symphysis slightly less than half the mandibular length, between 45 and 50% (shared with *Mystriosaurus*, *I. potamosiamensis* and *Deslongchampsina*); deep, well-developed reception pits throughout the anterior- to mid-maxilla and gradually disappear (similar to *Mystriosaurus*, *Charitomenosuchus* and *Deslongchampsina*); shallow Meckelian groove (shared with *Neosteneosaurus* and Machimosaurini); sharp dorsal curvature of the angular (shared with *Neosteneosaurus* and Machimosaurini); the P1 is oriented anteriorly whereas the P2 is oriented slightly medially (shared with *Proexochokefalos*).

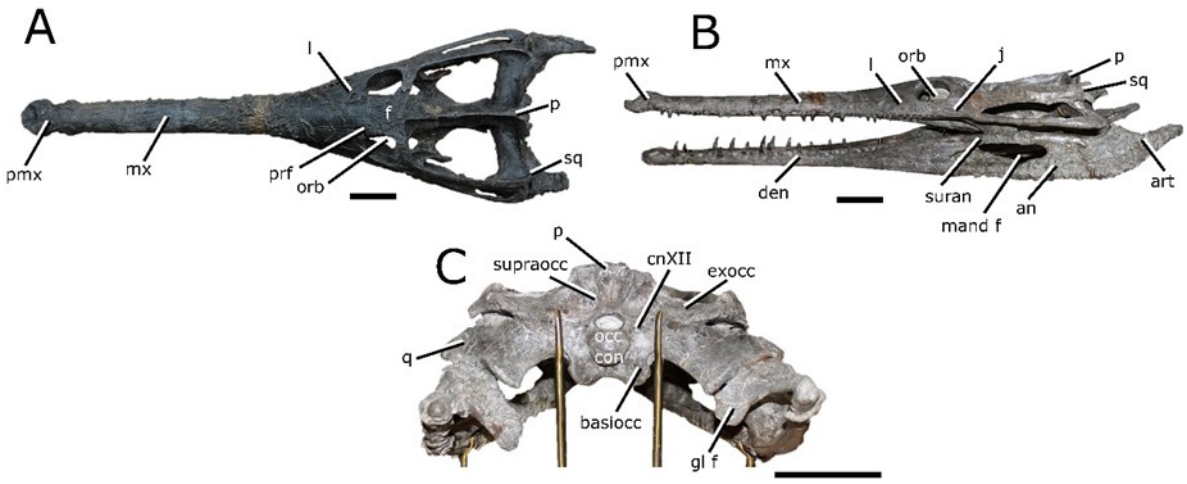


Figure 57. *Proexochokefalos heberti* (Morel de Glasville, 1876), **comb. nov.**, MNHN.F 1890-13, holotype. Skull in (A) dorsal, (B) left lateral and (C) occipital views. Refer to abbreviations list. Scale bars: 10 cm.

Gen. nov.

Proexochokefalos cf. *bouchardi* (Sauvage, 1872)

(Fig. 58)

Age: Kimmeridgian, Upper Jurassic.

Localities: Villerville, Calvados, France; Courtedoux-sur Combe Ronde, northwestern Switzerland.

Stratigraphic horizons: '*Calcaire de Caen*'; Reuchenette Formation.

Holotype: A partial specimen initially composed of a skull, mandible and assorted vertebrae (Vignaud, 1995). Currently missing and/or destroyed.

Referred material: Sauvage (1872); Buffetaut & Makinsky (1984); Lepage et al. (2008); SCR010-374 (Schaefer et al., 2018).

Scoring sources: Scores were based on specimen photographs from Lepage et al. (2008) and Schaefer et al. (2018). Additional information was read from Joleaud (1928) and Buffetaut & Makinsky (1984).

Emended diagnosis: mesorostrine skull; tooth row and occipital condyle aligned in the same plane (similar to the Chinese teleosauroid, *Charitomenosuchus*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); flat nasals with no evidence of a midline concavity (shared with *Proexochokefalos*); supratemporal fenestrae length is twice as long as width (shared with *Proexochokefalos* and *Neosteneosaurus*, and somewhat similar to Machimosaurini); frontal width broader than orbital width (shared with *Plagiophthalmosuchus*, *Mystriosaurus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Aeolodon*, *Bathysuchus*, *Neosteneosaurus*, *Mac. buffetauti* and *Mac. mosae*); orbit is ellipsoid in shape (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Platysuchus*, *Aeolodon*, *Macrospondylus*, *Charitomenosuchus*, *Seldsienean*, *Deslongchampsina*, *Proexochokefalos* and *Neosteneosaurus*).

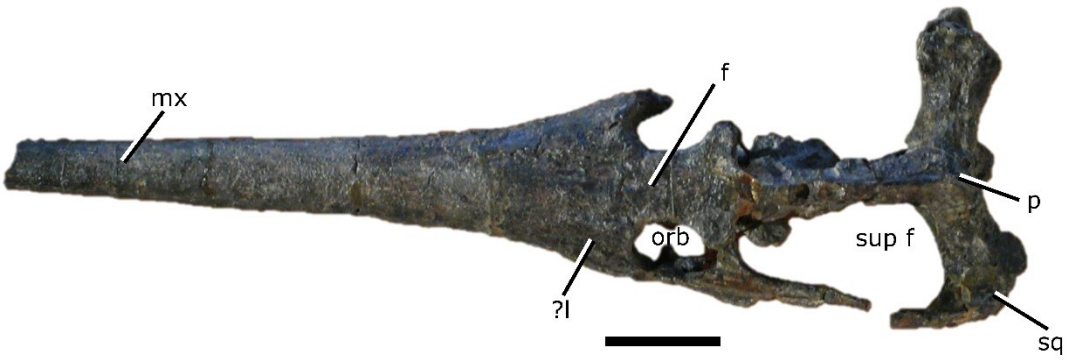


Figure 58. *Proexochokefalos* cf. *bouchardi* (Sauvage, 1872), **comb. nov.** Unknown specimen number, photo provided by Y. Lepgae (from Lepage et al., 2008). Skull in dorsal view. Refer to abbreviations list. Scale bar: 10 cm.

Remarks: The mandible of the holotype disappeared, while remnants of the skull material was initially sent to BHN2 (and was considered as the lectotype [presumably BHN2 R 59] by Buffetaut et al. (1986)). However, this museum was closed down in 2003 and the current whereabouts of the material is unknown. In addition, Vignaud (1995) considered the remaining vertebrae of the holotype (location also unknown) as the paralectotype, with no explanation as to why. In 1892, M. Makinsky discovered the skull figured in Lepage et al. (2008) in the Pictonia baylei ammonite zone (lower Kimmeridgian) near Villerville (Calvados, France). Buffetaut & Makinsky (1984) described it as '*Steneosaurus*' cf. *bouchardi*; currently the location of this skull, as with all holotype material, is not known (Y. Lepage, pers. comm.). Due to the close phylogenetic placement of this taxon to *Proexochokefalos heberti*, it is currently considered to be in the same genus.

Steneosaurus rostromajor Geoffory Saint-Hilaire, 1825

(Fig. 59)

Age: Callovian or Oxfordian, Middle or Late Jurassic (hypothesized Lower Oxfordian).

Locality: Vaches Noires, Calvados, France.

Stratigraphic horizon: Possibly Marnes de Villiers Formation.

Holotype: MNHN.RJN 134, a partial rostrum.

Scoring sources: The holotype (MNHN.RJN 134c-d) was examined first-hand.

Description: maxillae ornamented with numerous, weakly- to strongly-developed grooves; moderately interdigitating premaxilla-maxilla dorsal suture (shared with *Mystriosaurus*, *Proexochokefalos*, *Andrianavoay*, *Neosteneosaurus* and Machimosaurini); deep, pronounced reception pits throughout the entirety of the maxilla (shared with *Andrianavoay*, *Neosteneosaurus*, and Machimosaurini); at least 27 maxillary alveoli; mainly circular, well spaced maxillary alveoli throughout the entirety of the rostrum; posterior maxillary alveoli slightly smaller than anterior maxillary alveoli (similar to *Yvridiosuchus*); well-developed, pronounced enamel ridges near the base of the tooth.

Remarks: The type specimen of the genus *Steneosaurus* is represented by *Steneosaurus rostromajor* (Geoffroy Saint-Hilaire, 1825, 1831). Initially, this species was composed of a rostrum (MNHN.RJN 134c-d) and orbital region (MNHN.RJN 134a-b); however, the orbital section represents a metriorhynchid. The validity of this taxon has been called into question due to its fragmentary nature (e.g. Eudes-Deslongchamps, 1867-69) and overall paraphyletic phylogenetic positioning of *Steneosaurus* in multiple phylogenetic studies (e.g. Mueller-Töwe, 2006; Ősi et al., 2018; Foffa et al., 2019; Johnson et al., 2019). Currently, only one species can hypothetically be referable to *S. rostromajor*, *Neosteneosaurus edwardsi* (see Chapter VI for more details).

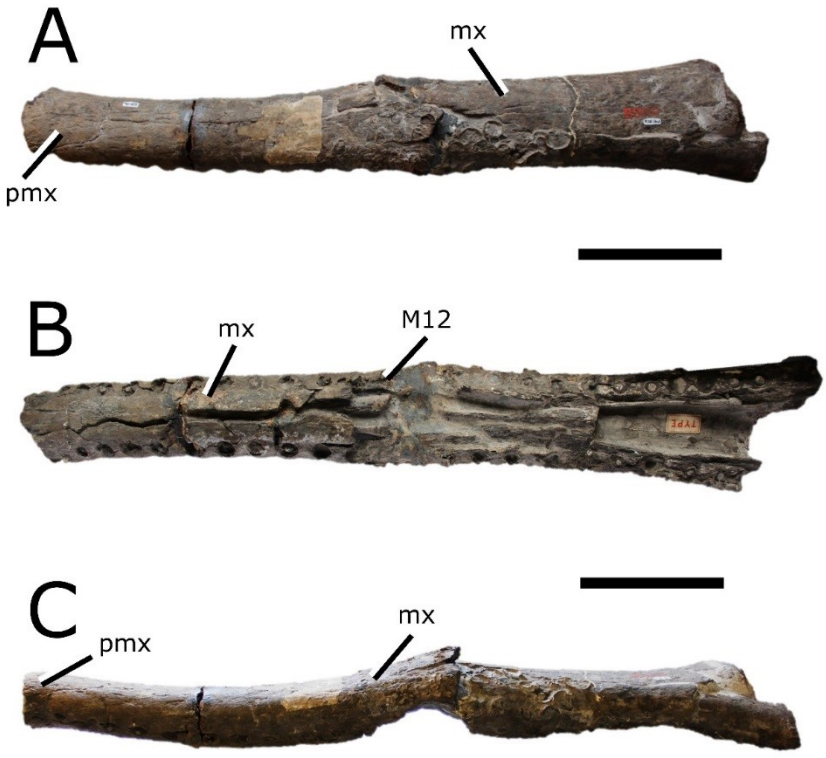


Figure 59. *Steneosaurus rostromajor* (Geoffroy Saint-Hilaire, 1825), MNHN.RJN 134c-d, holotype. Partial rostrum in (A) dorsal, (B) ventral and (C) left lateral views. Refer to abbreviations list. Scale bar: 10 cm.

Gen. nov.

Andrianavoay baroni (Newton, 1893)

(Fig. 60)

Type species: *Steneosaurus baroni* Newton, 1893. Now referred to as *Andrianavoay baroni* (Newton, 1893), **comb. nov.**

Etymology: 'Noble crocodile'. *Andrian'* and *voay* are Malagasy meaning noble (usually referring to a prince) and crocodile, respectively.

Age: Bathonian, Middle Jurassic.

Locality: Andranosamonta, northwestern Madagascar.

Stratigraphic horizon: Unknown.

Holotype: NHMUK PV R 1999, a partial skull and mandible with one associated osteoderm.

Scoring sources: The holotype (NHMUK PV R 1999) was examined first-hand.

Autapomorphic characters: sparse, small, deep subcircular foramina on the posterior and lateral margins of the external nares.

Emended diagnosis: maxilla ornamented with numerous, shallow to deep grooves; premaxillary anterior and anterolateral margins are not sub-vertical (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Charitomenosuchus*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); moderately interdigitating premaxilla-maxilla dorsal suture (shared with *Mystriosaurus*, *Proexochokefalos*, *Neosteneosaurus*, *S. rostromajor* and Machimosaurini); dorsoventrally deep posterior premaxilla (shared with *Proexochokefalos*); anteroposteriorly thin posterior-most parietal*; dorsoventrally tall supraoccipital (shared with *Plagiophthalmosuchus*, *Clovesuurdameredeor* and *Lemmysuchus*); deep, pronounced reception pits throughout the entirety of the maxilla (shared with *S. rostromajor*, *Neosteneosaurus* and Machimosaurini); osteoderm fragment with large, circular pits that are well separated from one another.

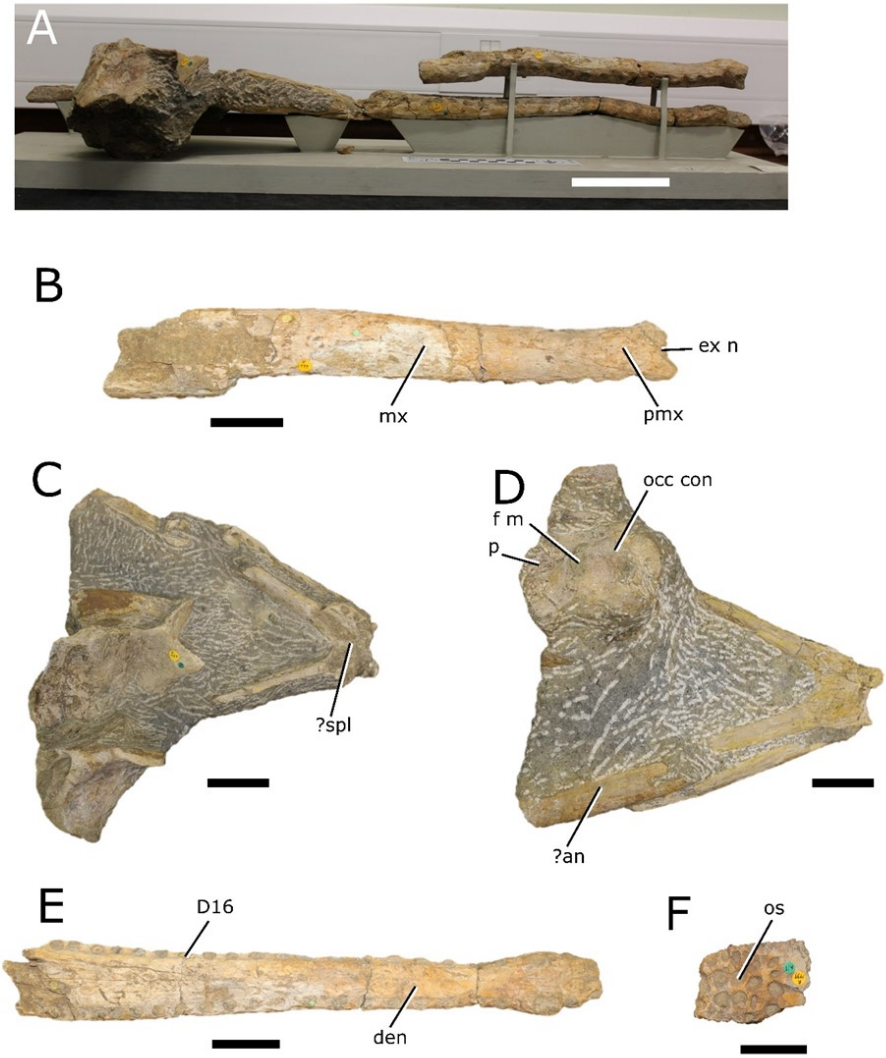


Figure 60. *Andrianavoay baroni* (Newton, 1893), **comb. nov.**, NHMUK PV R 1999, holotype. Photograph of the partial skull and mandible in (A) right lateral view, as well as (B) partial rostrum in dorsal view; posterior skull in (C) dorsal and (D) ventral views; (E) partial mandible in dorsal view; and (F) fragment of osteoderm in dorsal view. Refer to abbreviations list. Scale bars: 10 cm (A), 5 cm (B-E) and 3 cm (F).

Gen. nov.

Neosteneosaurus edwardsi (Eudes-Deslongchamps, 1868a)

(Fig. 61-63)

Type species: *Steneosaurus edwardsi* Eudes-Deslongchamps, 1868a. Now referred to as *Neosteneosaurus edwardsi* (Eudes-Deslongchamps, 1868a), **comb. nov.**

Etymology: 'New *Steneosaurus*'. '*Neo-*' is from the Greek *neos* (νέος) meaning 'new'. Refers to the genus this species previously belonged to, '*Steneosaurus*'.

Age: Middle Callovian, Middle Jurassic.

Locality: Peterborough, UK.

Stratigraphic horizon: Peterborough Member, Oxford Clay Formation, Ancholme Group.

Holotype: MNHN.RJN 118, a partial skull.

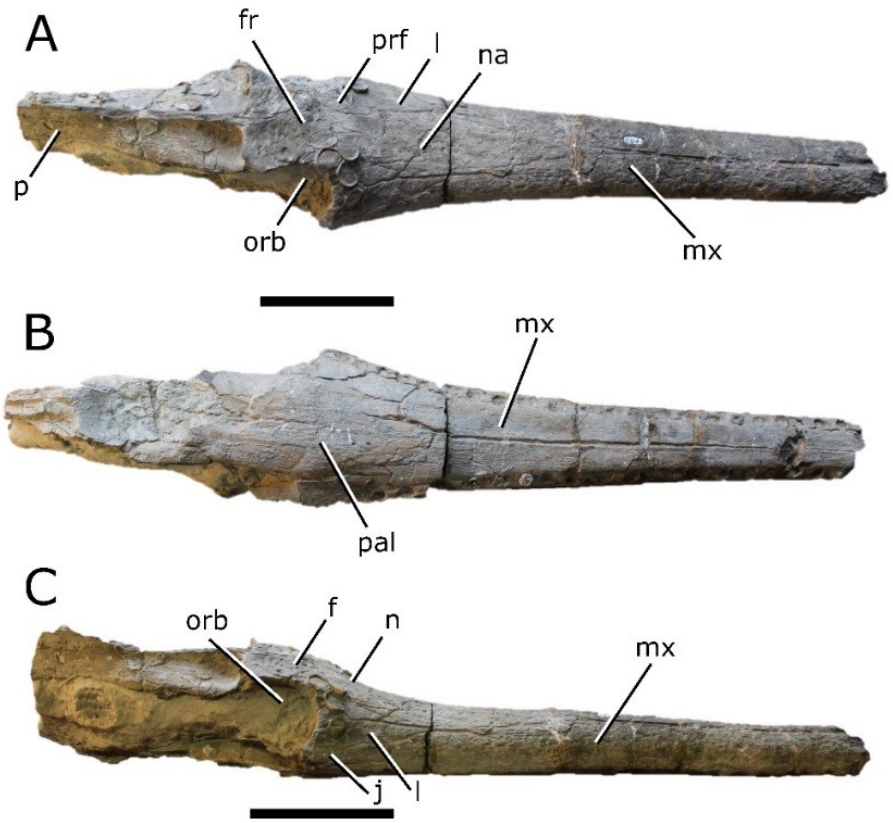


Figure 61. *Neosteneosaurus edwardsi* (Eudes-Deslongchamps, 1868a), **comb. nov.**, MNHN.RJN 118, holotype. Partial skull in (A) dorsal, (B) ventral (palatal) and (C) right lateral views. Refer to abbreviations list. Scale bars: 10 cm.

Referred material: GPIT-RE-7286 (complete skeleton); NHMUK PV R 2075 (partial skull, mandible and associated postcrania); NHMUK PV R 2076 (partial mandible and femora, ilia, tibia, ulna, dorsal and sacral osteoderms);

NHMUK PV R 2619 (partial skull and mandible with associated postcrania); NHMUK PV R 2865 (complete skull, assorted vertebrae and isolated teeth); NHMUK PV R 3701 (nearly complete skull and mandible, and partial skeleton); NHMUK PV R 3898 (femur, ilium and ischium); NRM-PZ R.144 (a partial sacral vertebra); NRM-PZ R.2053 (tibia); NRM-PZ R.2074 (femur); OUMNH J.29815 (partial skull); PETMG R175 (complete skeleton); PETMG R178 (nearly complete skeleton); SMF R 123 (complete skull and nearly complete mandible).

Scoring sources: The holotype (MNHN.RJN 118), as well as all additional referred specimens, were examined first-hand.

Figure 62. *Neosteneosaurus edwardsi* (Eudes-Deslongchamps, 1868a), **comb. nov.**, PETMG R178, referred specimen. Nearly complete skull and mandible in right lateral view. Scale bars: 10 cm.

Autapomorphic characters: posterior-most teeth with sub-pointed apices (are not blunt and rounded but significantly less pointed than in anterior and middle dentition); tuberculum and articular facet of the dorsal rib positioned on the lateromedial edge.

Emended diagnosis: mesorostrine snout; tooth row and occipital condyle aligned, and quadrate condyle at a lower level (shared with the Chinese teleosauroid, *Charitomenosuchus*, *Proexochokefalos*, *Pr*. cf. *bouchardi* and Machimosaurini); frontal ornamentation restricted to centre (shared with *Sericodon*, *Aeolodon*, *Charitomenosuchus*, *Seldsienean*, *Deslongchampsina*, *Proexochokefalos* and Machimosaurini); external nares oriented dorsally (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Charitomenosuchus*, *Deslongchampsina*, *Proexochokefalos*, and Machimosaurini); premaxillary anterior and anterolateral margins are not sub-vertical (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Andrianavoay*, *Charitomenosuchus*, *Deslongchampsina*, *Proexochokefalos* and

Machimosaurini); moderately interdigiting premaxilla-maxilla suture, appearing subcircular in shape (shared with *Mystriosaurus*, *Andrianavoay*, *S. rostromajor*, *Lemmysuchus* and *Machimosaurus*); absence of antorbital fenestrae (shared with *Proexochokefalos* and Machimosaurini); supratemporal fenestrae length is twice as long as width (shared with *Proexochokefalos* and *Pr*. cf. *bouchardi*, and somewhat similar to Machimosaurini); the anterior process of the jugal is slender, elongated and extends anteriorly (shared with *Clovesuurdameredeor*, *Proexochokefalos* and Machimosaurini); orbit is longitudinal ellipsoid in shape (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Platysuchus*, *Aeolodon*, *Macrospondylus*, *Charitomenosuchus*, *Seldsienean*, *Pr*. cf. *bouchardi*, *Proexochokefalos* and *Deslongchampsina*); frontal width broader than orbital width (shared with *Plagiophthalmosuchus*, *Mystriosaurus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus*, *Aeolodon*, *Pr*. cf. *bouchardi*, *Mac. buffetauti* and *Mac. mosae*); squamosal projects further posteriorly than occipital condyle (shared with the Chinese teleosauroid and Machimosaurini); shallow Meckelian groove (shared with *Proexochokefalos* and Machimosaurini); mandibular symphysis between 30 to 45% of the mandibular length; (shared with Machimosaurini); deep, pronounced reception pits throughout the entirety of the maxilla (shared with *Andrianavoay*, *Neosteneosaurus*, and Machimosaurini); maxillary teeth not procumbent (shared with *Proexochokefalos* and Machimosaurini); large, robust, weakly-compressed teeth with a pointed apex and high relief enamel ridges (similar to *Deslongchampsina*); postacetabular iliac process is fan-shaped (shared with *Charitomenosuchus*, *Lemmysuchus* and *Mac. mosae*); tibia approximately 40-50% shorter than the femur (shared with *Mycterosuchus*, *Charitomenosuchus*, *Lemmysuchus* and *Mac. mosae*); medial femoral condyle larger than lateral femoral condyle (shared with *Mycterosuchus*, *Charitomenosuchus* and *Machimosaurus*); elongated and pronounced keel across the entirety of the sacral dorsal osteoderms (shared with *Lemmysuchus*).

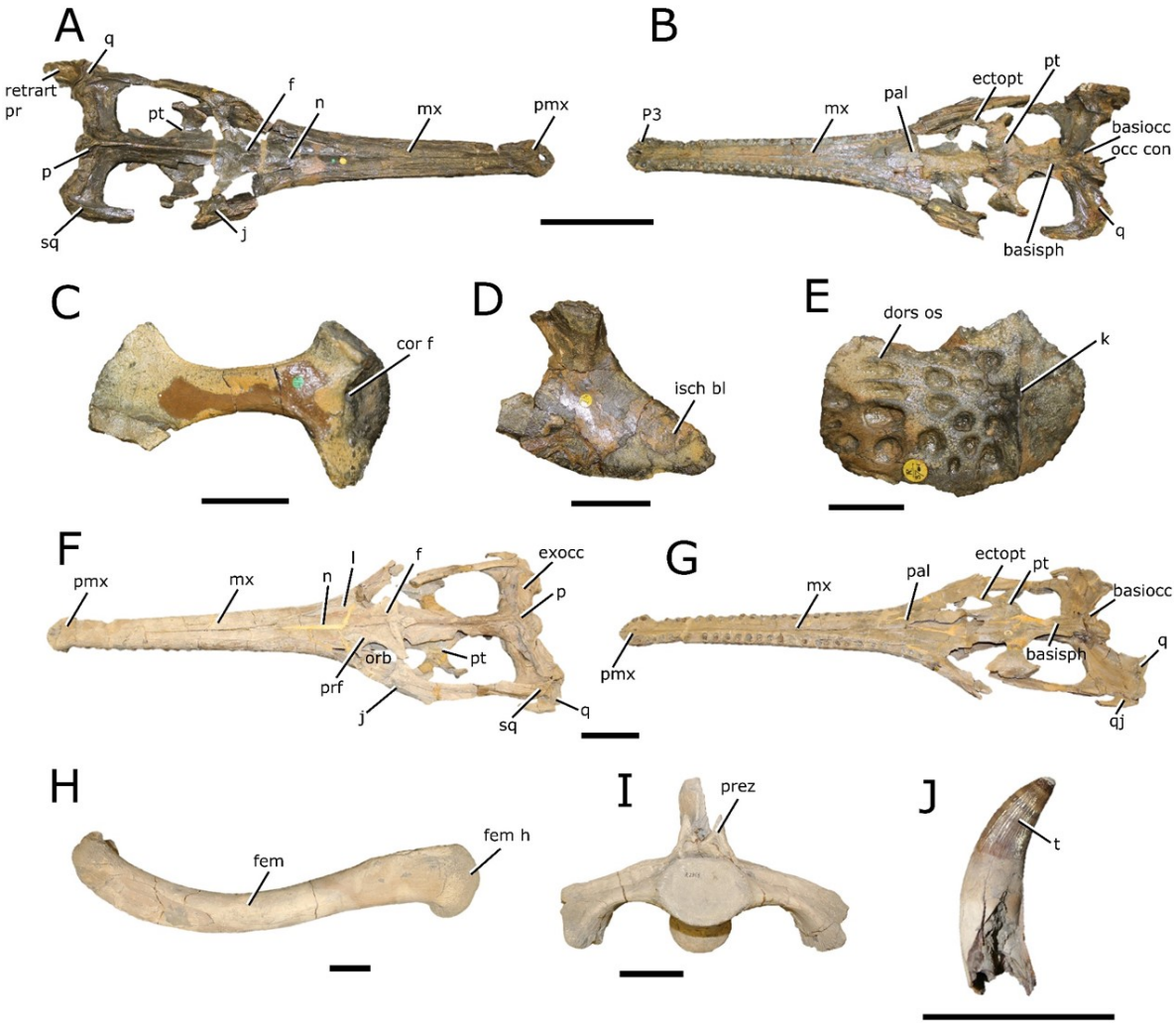


Figure 63. *Neosteneosaurus edwardsi* (Eudes-Deslongchamps, 1868a), **comb. nov.**, referred specimens. (A-E) NHMUK PV R 3701: skull in (A) dorsal and (B) ventral (palatal) views; (C) coracoid; (D) ischium; and (E) dorsal osteoderm. (F-J) NHMUK PV R 2865: skull in (F) dorsal and (G) ventral (palatal) views; (H) femur; (I) first sacral vertebra; and (J) tooth. Refer to abbreviations list. Scale bars: 10 cm (A-B, F-G), 5 cm (D, H-I) and 3 cm (C, E, J).

Yvridiosuchus boutilieri (Eudes-Deslongchamps, 1868c) Johnson et al., 2019

(Fig. 64-65)

Age: Bathonian, Middle Jurassic.

Localities: Calvados, France; Enslow Bridge, Oxfordshire, UK.

Stratigraphic horizons: '*Sommet de la Grande Oolithe*'; Great Oolite Group.

Holotype: A skull fragment figured by Eudes-Deslongchamps (1867-69), presumed to be lost or destroyed (Vignaud, 1995).

Neotype: OUMNH J.1401, a partial skull.

Referred material: OUMNH J.29850 (nearly complete skull and mandible); OUMNH J.1403 (nearly complete skull); OUMNH J.1404 (partial mandible); OUMNH J.1417 (partial mandible).

Scoring sources: The neotype (OUMNH J.1401), as well as all referred specimens mentioned above, were studied first-hand.

Autapomorphic characters: heavily ornamented lacrimal, appearing perforated in lateral view; extreme elongation of the anterior jugal, so that it participates in the posterior margin of the antorbital fenestrae; orbit subcircular in shape; anterior process shape of palatine U-shaped; width of retroarticular process is narrower than the glenoid fossa.

Emended diagnosis: mesorostrine skull; skull ornamented with conspicuous pits and grooves; (differs from that seen in *Mycterosuchus* and *Mystriosaurus*); large and numerous neurovascular foramina on the premaxillae, maxillae and dentaries (shared with *Mystriosaurus* and Machimosaurini); external nares oriented dorsally (shared with *Plagiophthalmosuchus*, *Macrospondylus* , *Charitomenosuchus*, *Proexochokefalos*, *Deslongchampsina*, *Neosteneosaurus* and other members of Machimosaurini); premaxillary anterior and anterolateral margins are not sub-vertical (shared with *Plagiophthalmosuchus*, *Macrospondylus* , *Andrianavoay*, *Charitomenosuchus*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini); presence of small, deep antorbital fenestrae; frontal width subequal with orbital width (shared with the Chinese teleosauroid, *Mycterosuchus*, *Proexochokefalos*, *Deslongchampsina*, *Mac. hugii*, and *Mac. rex*); squamosal projects further posteriorly than occipital condyle (shared with the Chinese teleosauroid, *Neosteneosaurus* and other members of Machimosaurini); shallow Meckelian groove) (shared with *Proexochokefalos*, *Neosteneosaurus* and other

members of Machimosaurini); sharp dorsoposterior curvature of the posterior mandibular rami (shared with *Proexochokefalos* and *Lemmysuchus*); teeth large and conical with blunt apices (shared with other members of Machimosaurini); teeth not mediolaterally compressed (shared with *Bathysuchus* and other members of Machimosaurini); carinae heterogeneous with faint denticles (shared with other members of Machimosaurini); teeth with anastomosing pattern on the apical surface (shared with other members of Machimosaurini);maxillary teeth not procumbent (shared with *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini).

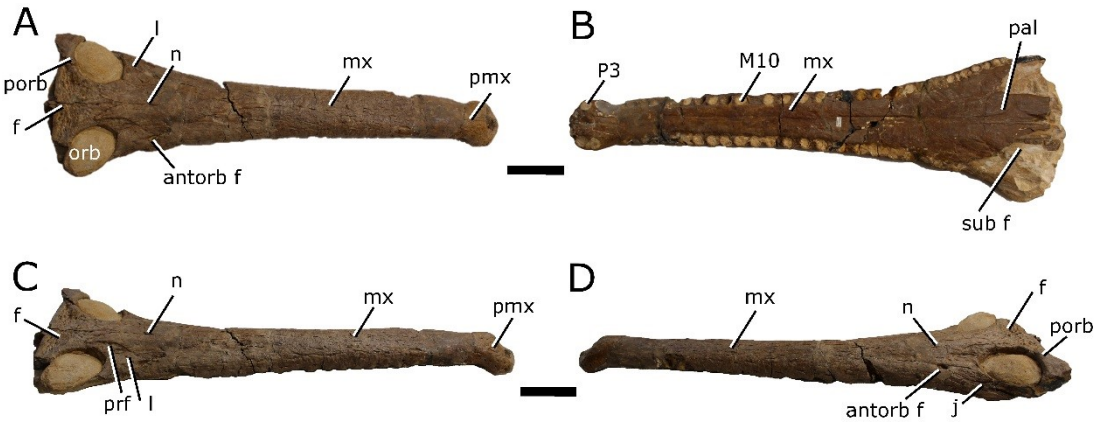


Figure 64. *Yvridiosuchus boutilieri* (Eudes-Deslongchamps, 1868c) Johnson et al., 2019, OUMNH J.1401, holotype. Skull in (A) dorsal, (B) ventral (palatal), (C) right lateral and (D) left lateral views. Refer to abbreviations list. Scale bars: 5 cm.

Remarks: *Yvridiosuchus* has a long and complicated taxonomic history, including an invalid species name (*Crocodilus oxoniensis*; as by the ICZN), and OUMNH J.1401 (the designated neotype) considered by Eudes-Deslongchamps (1867-69) as "*appartenant à la même espèce*" ["belonging to the same species"] to the previously destroyed French holotype (see Johnson et al., 2019: Chapter III for in-depth detail). In addition, *Teleosaurus* ('*Steneosaurus*') brevidens Phillips, 1871, and '*Steneosaurus*' *meretrix* Phizackerely, 1951, are both junior synonyms of *Yvridiosuchus* (Johnson et al., 2019; see Chapter III).

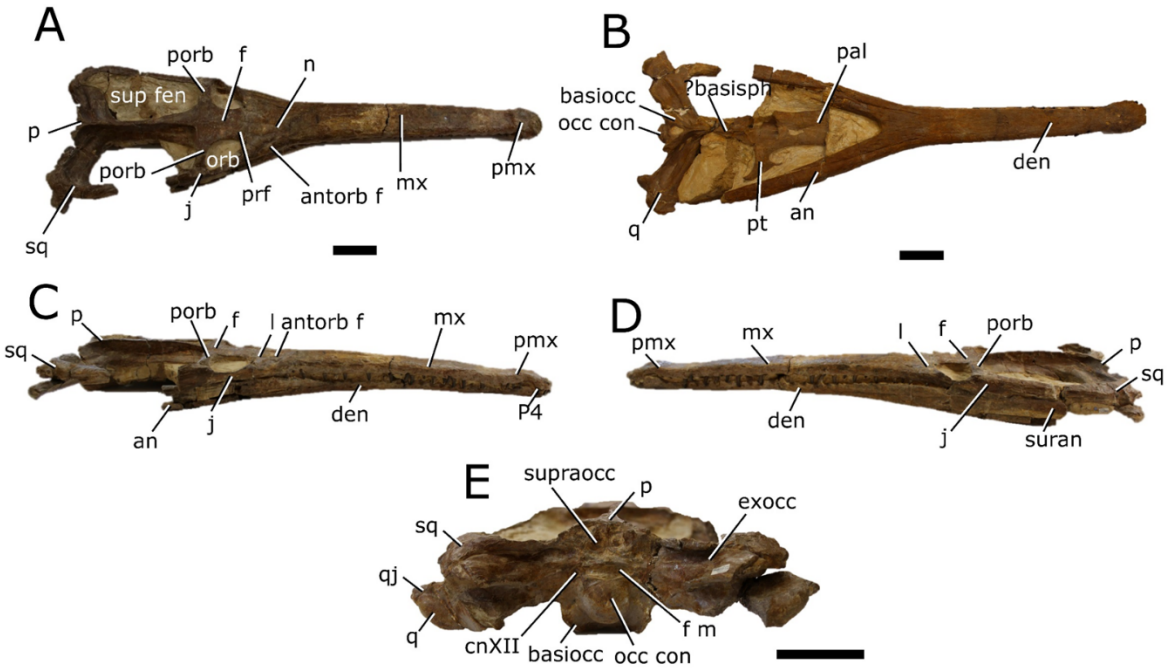


Figure 65. *Yvridiosuchus boutilieri* (Eudes-Deslongchamps, 1868c) Johnson et al., 2019, OUMNH J.29850, referred specimen. Skull in (A) dorsal, (B) ventral (palatal), (C) right lateral, (D) left lateral and (E) occipital views. Refer to abbreviations list. Scale bars: 5 cm.

Lemmysuchus obtusidens (Andrews, 1909) Johnson et al., 2017

(Fig. 66-67)

Age: Middle Callovian, Middle Jurassic.

Locality: Peterborough, UK.

Stratigraphic horizon: Peterborough Member, Oxford Clay Formation, Ancholme Group.

Holotype: NHMUK PV R 3168, a nearly complete skeleton including the skull, mandible, vertebrae, hindlimbs, and multiple osteoderms.

Referred material: LPP.M.21 (a nearly complete skull and mandible); NOTNH FS3361 (a partial rostrum); PETMG R39 (a rostral-orbital section).

Scoring sources: The holotype (NHMUK PV R 3168) and all referred specimens mentioned above were studied first-hand.

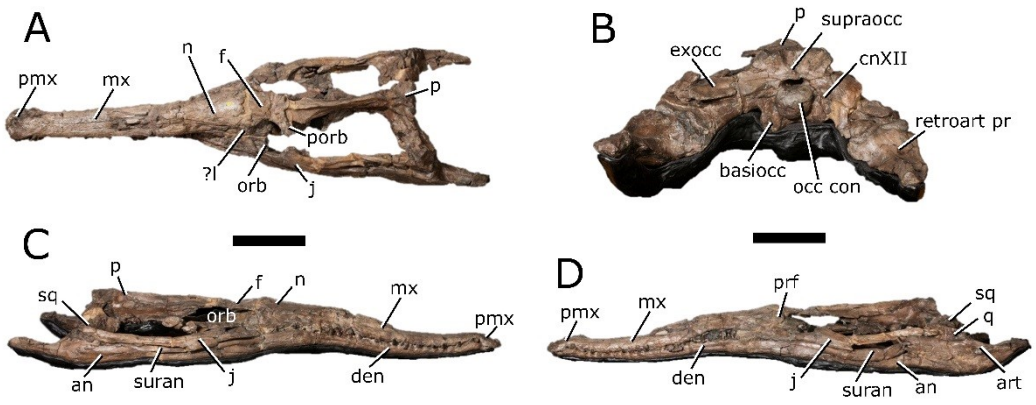


Figure 66. *Lemmysuchus obtusidens* (Andrews, 1909) Johnson et al., 2017, NHMUK PV R 3168, holotype. Skull in (A) dorsal, (B) occipital, (C) right lateral and (D) left lateral views. Refer to abbreviations list. Scale bars: 20 cm.

Autapomorphic characters: the rostrum external surface is strongly convex, in particular the nasals; partial or complete fusion of the internasal suture; nasal midline cavity poorly developed; eight cervical vertebrae; dorsoventrally curved cervical ribs; ilium anterior process is small and anteroposteriorly shortened; acetabulum is shallow and poorly developed; shallow supraacetabular crest on the ilium; anterior ischial process reduced; dorsal osteoderms with small-to-large, irregularly shaped pits that radiate from the centre of the keel and are arranged in a starburst pattern (to a certain extent similar to *Mac. mosae*).

Emended diagnosis: mesorostrine skull; external nares oriented dorsally (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini); two parallel lines of large, circular neurovascular foramina on the premaxillae and maxillae, and a clustering of foramina on the lateral surface of the premaxillae (shared with other members of Machimosaurini); premaxillary anterior and anterolateral margins are not sub-vertical (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Andrianavoay*, *Charitomenosuchus*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini); moderately interdigiting premaxilla-maxilla suture, appearing subcircular in shape (shared with *Mystriosaurus*, *Andrianavoay*, *Neosteneosaurus*, *S. rostromajor*,

and *Machimosaurus*); absence of antorbital fenestrae (shared with *Proexochokefalos*, *Neosteneosaurus* and *Machimosaurus*); parallelogram-shaped supratemporal fenestrae (shared with other members of Machimosaurini); the anterior process of the jugal is slender, elongated and extends anteriorly (shared with *Clovesuurdameredeor*, *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini); squamosal project posteriorly to occipital condyle (shared with *Plagiophthalmosuchus*, the Chinese teleosauroid, *Neosteneosaurus* and *Yvridiosuchus*); supraoccipital dorsoventrally tall (shared with *Plagiophthalmosuchus*, *Clovesuurdameredeor* and *Andrianavoay*); shallow Meckelian groove (shared with *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini); retroarticular process subequal to glenoid fossa width (shared with *Aeolodon* and *Mac. buffetauti*); teeth large and conical with blunt apices (shared with other members of Machimosaurini); teeth not mediolaterally compressed (shared with *Bathysuchus* and other members of Machimosaurini); carinae heterogeneous with faint denticles (shared with other members of Machimosaurini); teeth with anastomosing pattern on the apical surface (shared with other members of Machimosaurini); axis lacks diapophyses (shared with *Macrospondylus*); three sacrals (shared with *Machimosaurus*); dorsal ribs with pronounced tuberculum (shared with *Mycterosuchus*, *Neosteneosaurus* and *Machimosaurus*); postacetabular iliac process is fan-shaped (shared with *Charitomenosuchus*, *Neosteneosaurus* and *Mac. mosae*); posteroventral margin of ischial plate sub-squared (shared with *Mac. mosae*); tibia approximately 40-50% shorter than the femur (shared with *Mycterosuchus*, *Charitomenosuchus*, *Neosteneosaurus* and *Mac.*

mosae); tibial tuberosity angled ventrally (shared with *Mac. mosae*); elongate and pronounced keel on sacral osteoderms (shared with *Neosteneosaurus*).

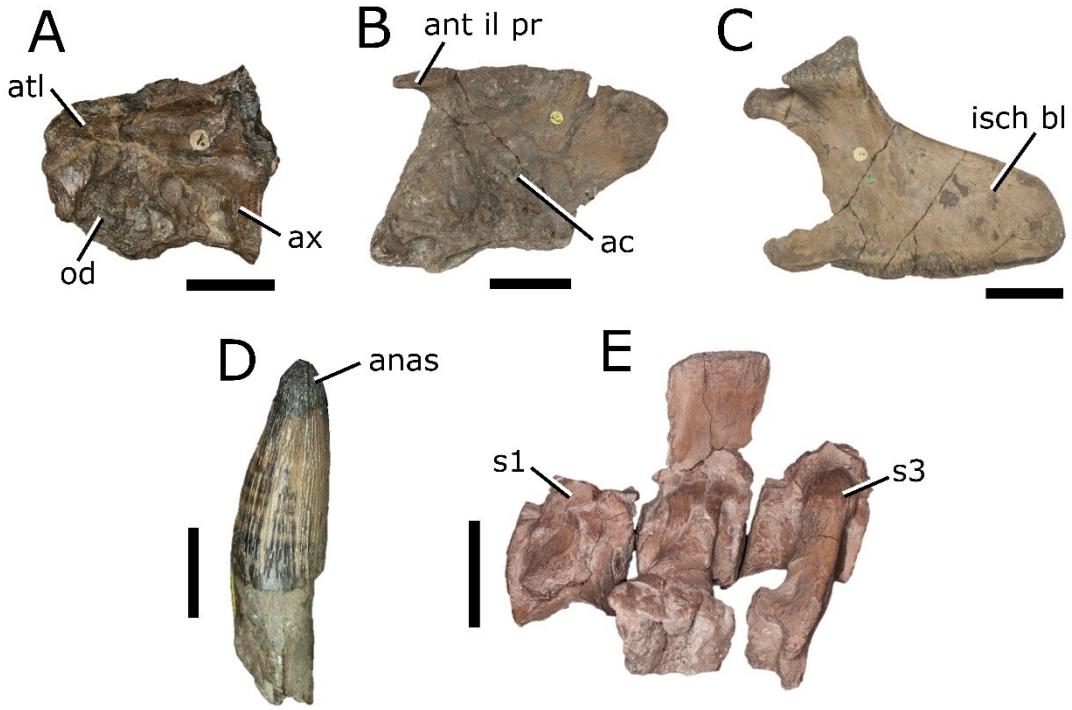


Figure 67. *Lemmysuchus obtusidens* (Andrews, 1909) Johnson et al., 2017, NHMUK PV R 3168, holotype. Associated material, including: (A) atlas-axis complex; (B) ilium; (C) ischium; (D) isolated tooth; and (E) sacral vertebrae. Note the three sacrals, as well as the anastomosing pattern on the tooth apex. Refer to abbreviations list. Scale bars: 5 cm (A-C, E) and 2 cm (D).

Remarks: The locality and stratigraphic horizon of LPP.M.21, which comes from France, is currently unknown.

Machimosaurus buffetauti Young et al., 2015

(Fig. 68-69)

Age: *Ataxioceras hypselocyclum* Sub-Mediterranean ammonite Zone (=Weißer Jura gamma 2), Lower Kimmeridgian, Upper Jurassic.

Localities: Am Hörnle Quarry, Neuffen, Baden-Württemberg, Germany; lower Saxony, Germany; Cricqueboeuf, Normandy, Northern France

Stratigraphic horizons: Lacunosamergel Formation; Langenberg Formation; Calcaires Coquilliers Formation.

Holotype: SMNS 91415, a complete skull and mandible (as well as in situ teeth) with associated partial postcranial skeleton including cervical and dorsal vertebrae, one coracoid and multiple osteoderms.

Referred material: DFMMh FV 330; DFMMh FV 541; MPV V1600.Bo; MPV V1601.Bo.

Scoring sources: The holotype (SMNS 91415) was examined first-hand, and additional information was taken from Young et al. (2014a).

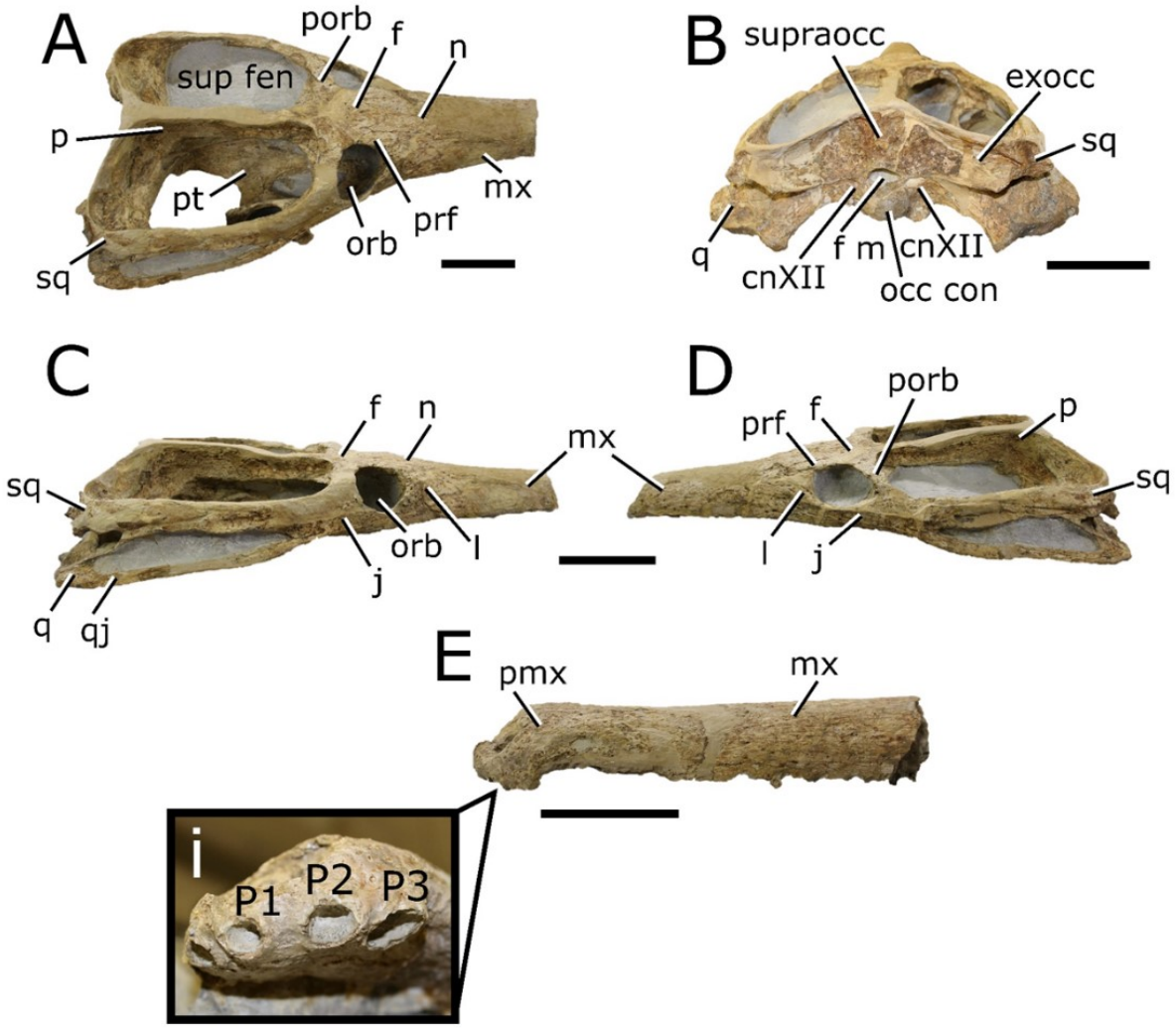


Figure 68. *Machimosaurus buffetauti* Young et al., 2015, SMNS 91415, holotype. Skull in (A) dorsal, (B) occipital, (C) right lateral and (D) left lateral views. Rostrum in (E) left lateral view, with a close-up of (i) the premaxillary alveoli. Refer to abbreviations list. Scale bars: 10 cm.

Autapomorphic characters: anterolateral frontal projections between nasals and prefrontals; squamosal approximately level with occipital condyle; retroarticular process is slightly longer than wide; low post-symphyseal tooth count of the dentary; dorsal margin of the axis neural arch is strongly concave in lateral view; tuberculum and articular facet of dorsal ribs slightly situated on the medial edge; elongated coracoid glenoid process that extends considerably from the proximal coracoid, and sub-isosceles triangle-shaped in lateral view; anterior margin of the coracoid postglenoid process is slightly concace and terminates approximately in the same frontal plane as the glenoid; posterior margin of the coracoid postglenoid process is strongly concave and terminates approximately in the same frontal plane as the posterior end of the glenoid process; dorsal osteoderms with generally small, irregularly shaped pits arranged in a random pattern, with a shallow keel.

Emended diagnosis: mesorostrine skull; rostrum wider than high (shared with other members of *Machimosaurus*); two parallel lines of large, circular neurovascular foramina on the premaxillae and maxillae, and a clustering of foramina on the lateral surface of the premaxillae (shared with *Mystriosaurus* and members of Machimosaurini); dentary neurovascular foramina form a relatively straight line (shared with *Mac. mosae*); external nares oriented dorsally (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini); premaxillary anterior and anterolateral margins are not sub-vertical (shared with *Plagiophthalmosuchus*, *Macrospondylus* , *Andrianavoay*, *Charitomenosuchus*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini); premaxilla less than 25% of rostral length (shared with *Mystriosaurus*, the Chinese teleosauroid and *Mac. mosae*); absence of antorbital fenestrae (shared with *Proexochokefalos*, *Neosteneosaurus*, *Lemmysuchus* and *Mac. mosae*); parallelogram-shaped supratemporal fenestrae (shared with other members of Machimosaurini); extreme elongation of the supratemporal fenestrae (shared with other members of *Machimosaurus*); frontal width broader than orbital width (shared with *Plagiophthalmosuchus*, *Mystriosaurus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus*, *Aeolodon*, *Pr*. cf. *bouchardi*, *Neosteneosaurus* and *Mac. mosae*); circular orbits (shared with

Mystriosaurus, *Indosinosuchus*, *Teleosaurus*, *Mycterosuchus*, *Clovesuurdameredeor*, *Lemmysuchus* and other members of *Machimosaurus*); the anterior process of the jugal is slender, elongated and extends anteriorly (shared with *Clovesuurdameredeor*, *Proexochokefalos*, *Neosteneosaurus* and Machimosaurini); quadrates with a single large, circular depression on the dorsal surface close to the hemicondyles; shallow Meckelian groove (shared with *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini); retroarticular width is subequal to the glenoid fossa (shared with *Aeolodon* and *Lemmysuchus*); three premaxillary alveolar pairs (shared with other members of Machimosaurini); 21-28 maxillary alveolar pairs; deep, pronounced reception pits throughout the entirety of the maxilla (shared with *Andrianavoay*, *S. rostromajor*, *Neosteneosaurus* and other members of Machimosaurini); teeth large and conical with blunt apices (shared with other members of Machimosaurini); teeth not mediolaterally compressed (shared with *Bathysuchus* and other members of Machimosaurini); carinae heterogeneous with faint denticles (shared with other members of Machimosaurini); presence of keeled carinae variable (shared with *Mac. hugii* and *Mac. rex*); teeth with anastomosing pattern on the apical surface (shared with other members of Machimosaurini).

Remarks: The correct nominal authority is the short taxonomic note Young et al., 2015, not Young et al. 2014a (where the new taxon was described).

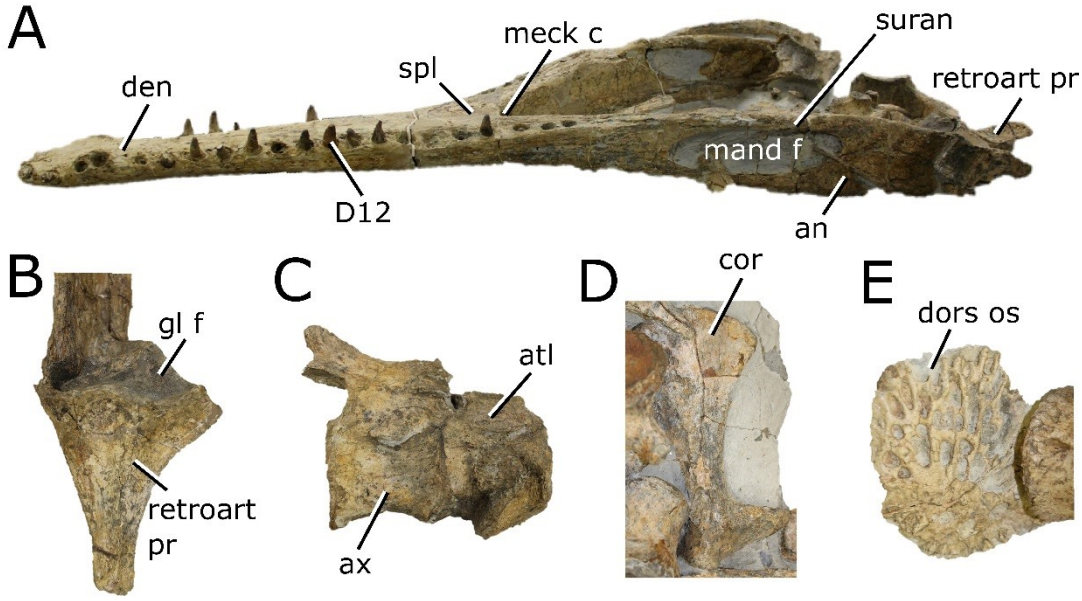


Figure 69. *Machimosaurus buffetauti* Young et al., 2015, SMNS 91415, holotype. Mandible in (A) left lateral view, in addition to: (B) retroarticular process in dorsal view; (C) atlas-axis complex; (D) coracoid; and (E) dorsal osteoderm. Refer to abbreviations list. Not to scale.

Machimosaurus mosae Sauvage & Liénard, 1879

(Fig. 70)

Age: Either the *Aulacostephanus autissiodorensis* Sub-Boreal ammonite Zone, uppermost Kimmeridgian, or the *Gravesia gigas*/*Pectinaties elegans* Sub-Boreal ammonite Zone, lowermost Tithonian; Upper Jurassic (neotype locality).

Neotype locality: Beach near Ambleteuse, Boulonnais, Département du Pas-de-Calais, Nord Pas-de-Calais, France.

Neotype stratigraphic horizon: Argiles de Châtillon Formation.

Holotype: A skull, destroyed during the First World War. Location and horizon unknown.

Neotype: A partially complete skeleton, labelled as MHNB 1100. Current location unknown.

Referred material: IRSNB (cast of neotype, representing a complete skeleton); Hua (1999); Young et al (2014a).

Scoring sources: Young et al. (2014a). Additional information was gleaned from examining the large cast of *Mac. mosae* in the IRSNB exhibit.

Autapomorphic characters: skull width roughly 0.4; anterior palatal margin terminates at roughly the 11th to 14th maxillary alveoli; approximately 17 to 18 alveoli per maxilla; approximately 19 to 20 alveoli per dentary; coracoid glenoid process very short; anterior edge of the scapula is strongly concave compared to the posterior edge.

Emended diagnosis: mesorostrine skull; rostrum wider than high (shared with other members of *Machimosaurus*); conspicuous grooved-ridged ornamentation of maxilla (shared with *Mac. hugii* and *Mac. rex*); two parallel lines of large, circular neurovascular foramina on the premaxillae and maxillae, and a clustering of foramina on the lateral surface of the premaxillae (shared with *Mystriosaurus* and members of Machimosaurini); dentary neurovascular foramina form a relatively straight line (shared with *Mac. buffetauti*); external nares oriented dorsally (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini); premaxillary anterior and anterolateral margins are not sub-vertical (shared with *Plagiophthalmosuchus*, *Macrospondylus*, *Andrianavoay*, *Charitomenosuchus*, *Deslongchampsina*, *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini); premaxilla less than 25% of rostral length (shared with *Mystriosaurus*, the Chinese teleosauroid and *Mac. buffetauti*); absence of antorbital fenestrae (shared with *Proexochokefalos*, *Neosteneosaurus*, *Lemmysuchus* and other members of *Machimosaurus*); parallelogram-shaped supratemporal fenestrae (shared with other members of Machimosaurini); extreme elongation of the supratemporal fenestrae (shared with other members of *Machimosaurus*); frontal width broader than orbital width (shared with

Plagiophthalmosuchus, *Mystriosaurus*, *Platysuchus*, *Teleosaurus*, *Mycterosuchus*, *Bathysuchus*, *Aeolodon*, *Pr*. cf. *bouchardi*, *Neosteneosaurus* and *Mac. buffetauti*); circular orbits (shared with *Mystriosaurus*, *Indosinosuchus*, *Teleosaurus*, *Mycterosuchus*, *Clovesuurdameredeor*, *Lemmysuchus* and other members of *Machimosaurus*); shallow Meckelian groove (shared with *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini); three premaxillary alveoli (shared with other members of *Machimosaurus*); deep, pronounced reception pits throughout the entirety of the maxilla (shared with *Andrianavoay*, *S*. *rostromajor*, *Neosteneosaurus* and other members of Machimosaurini); teeth large and conical with blunt apices (shared with other members of Machimosaurini); teeth not mediolaterally compressed (shared with *Bathysuchus* and other members of Machimosaurini); carinae heterogeneous with faint denticles (shared with other members of Machimosaurini); teeth with anastomosing pattern on the apical surface (shared with other members of Machimosaurini); three sacral vertebrae (shared with other members of Machimosaurini excluding *Yvridiosuchus*); postacetabular iliac process is fan-shaped (shared with *Charitomenosuchus*, *Neosteneosaurus* and *Lemmysuchus*); posteroventral margin of ischial plate is sub-square (shared with *Lemmysuchus*); tibial tuberosity angled ventrally (shared with *Lemmysuchus*); dorsal osteoderms ornamented with small-to-large, irregularly shaped pits that radiate from the centre of the keel and are arranged in a starburst pattern (similar to an extent in *Lemmysuchus*).

Figure 70. *Machimosaurus mosae* Sauvage & Liénard, 1879, IRSNB cast. Not to scale.

Remarks: The diagnosis of *Machimosaurus mosae* has until recently been filled with uncertainty. Sauvage & Liénard (1879) initially diagnosed this taxon based on an incomplete skull, mandible and postcranial material. However, Krebs (1967) viewed it as a junior synonym to *Machimosaurus hugii*. Hua (1999) then regarded it as a distinct taxon and proposed a new diagnosis for it, based on a new specimen from the Kimmeridgian of Boulonnais (northwestern France) containing the skull, mandible and partial postcranial material. Pierce et al. (2009a) also considered *Mac. mosae* to be distinct from *Mac. hugii*, due to the position of it within their geometric morphometric analysis.

However, Martin & Vincent (2013) criticized Hua's (1999) and Pierce et al.'s (2009a) diagnoses, writing "most of the content of these diagnoses reveal to be either diagnostic at the genus level or to characterize all Teleosauridae". Martin & Vincent (2013) then showed that high variation in maxillary and dentary tooth counts among the various Callovian teleosaurids is "sufficient difference to discard such an interpretation (the synonymy)". However, Martin & Vincent (2013) synonymized *Mac. mosae* with *Mac. hugii*, thus re-opening an old debate as to whether or not *Machimosaurus* represented a monotypic genus, or if the differences found between *Mac. mosae* and *Mac. hugii* were ontogenetic. However, subsequent studies by Vignaud (1995), Hua (1999) and Young at al. (2014a) all considered *Mac. mosae* to be taxonomically distinct from *Mac. hugii*. Importantly, Young et al. (2014a) outlined five distinct points that strengthen the separation of *Mac. mosae* from *Mac. hugii*: (1) the *Mac. mosae* neotype is equivalent in size to *Mac. hugii* skulls from France and Germany; (2) lack of juvenile characteristics in any of the French and German *Mac. hugii* skulls; (3) the *Mac. mosae* neotype exhibits exostoses (the formation of new bone) in the femur, right pubis, and some caudal vertebrae; (4) there is a 3- to 5-million-year gap between the *Mac. mosae* neotype and the *Mac. hugii* skulls; and (5) loss of the prearticulars in *Mac. mosae*, which is not seen in *Mac. hugii*. There are also certain postcranial features that differentiate *Mac. mosae* and *Mac. hugii*, including the shape and size of the coracoid postglenoid and glenoid processes.

Machimosaurus hugii (von Meyer, 1837) emend. von Meyer, 1838

(Fig. 71)

Age: Kimmeridgian, Upper Jurassic.

Localities: Kreuzen Quarry at St. Verena, near Solothurn, Canton Solothurn, Switzerland; Guimarota coalmine, Leiria, NW Portugal.

Stratigraphic horizon: 'Rätschenbank' der Schildkrőtenschichten ("Solothurn Turtle Limestone, Reuchenette Formation"); Guimarota Strata, Alcobaça Formation.

Holotype: von Meyer (1837, 1838) never designated a holotype; when establishing *Mac. hugii*, he referred to isolated tooth crowns from Solothurn, Switzerland and Kahlenberg, Germany (syntypes).

Lectotype: NMS 8342, an isolated tooth crown.

Referred material: MCNV-CC-4; MG-25; MG-8730-1 (two rostral pieces); MG-8730-2 (occipital section); MG unnumbered; ML 647; ML 491; ML 657; ML 658; (isolated teeth); Young et al. (2014a).

Scoring sources: MG-8730-1, MG-8730-2 and MG unnumbered were examined first-hand, along with multiple teeth (e.g. LMH 16386; LMH 16399; MG 25; NZM-PZ R.2358a-g; SMF R 434a-b). Additional information was taken from Young et al. (2014a).

Autapomorphic characters: external surfaces of the cranial bones are poorly ornamented, particularly the rostrum and near the orbits; paroccipital processes greatly enlarged, mediolaterally elongated and with expanded lateral ends, and are larger than the exoccipital-opisthotics; in occipital view, the inter-basioccipital tubera notch is a large inverse 'U'-shape; dentary interalveolar spacing uniformly narrow.

Emended diagnosis: mesorostrine skull; rostrum wider than high (shared with other members of *Machimosaurus*); groove-ridged ornamentation present along the maxilla (shared with *Mac. mosae* and *Mac. rex*); circular orbits (shared with *Mystriosaurus*, *Indosinosuchus*, *Teleosaurus*, *Mycterosuchus*, *Clovesuurdameredeor*, *Lemmysuchus* and other members of *Machimosaurus*); frontal width sub-equal to orbital width (shared with the Chinese teleosauroid, *Indosinosuchus* sp., *Macrospondylus*, *Clovesuurdameredeor*, *Seldsienean*, *Deslongchampsina*, *Proexochokefalos*, *Yvridiosuchus* and *Mac. rex*); parallelogram-shaped supratemporal fenestrae (shared with other members of Machimosaurini); extreme elongation of the supratemporal fenestrae (shared with other members of *Machimosaurus*); circular orbits (shared with *Mystriosaurus*, *Indosinosuchus*, *Teleosaurus*, *Mycterosuchus*, *Clovesuurdameredeor*, *Lemmysuchus* and other members of *Machimosaurus*); shallow Meckelian groove (shared with *Proexochokefalos*, *Neosteneosaurus* and other members of Machimosaurini); three premaxillary alveolar pairs (shared with *Mac. buffetauti* and *Mac. mosae*); deep, pronounced reception pits throughout the entirety of the maxilla (shared with *Andrianavoay*, *S. rostromajor*, *Neosteneosaurus* and other members of Machimosaurini); teeth large and conical with blunt apices (shared with other members of Machimosaurini); teeth not mediolaterally compressed (shared with *Bathysuchus* and other members of Machimosaurini); carinae heterogeneous with faint denticles (shared with other members of Machimosaurini); presence of keeled carinae variable (shared with *Mac. buffetauti* and *Mac. rex*); teeth with anastomosing pattern on the apical surface (shared with other members of Machimosaurini); pseudodenticles

present (shared with *Mac. rex*); dorsal osteoderm ornamentation composed of small-to-large, well separated, irregularly shaped, randomly arranged pits.

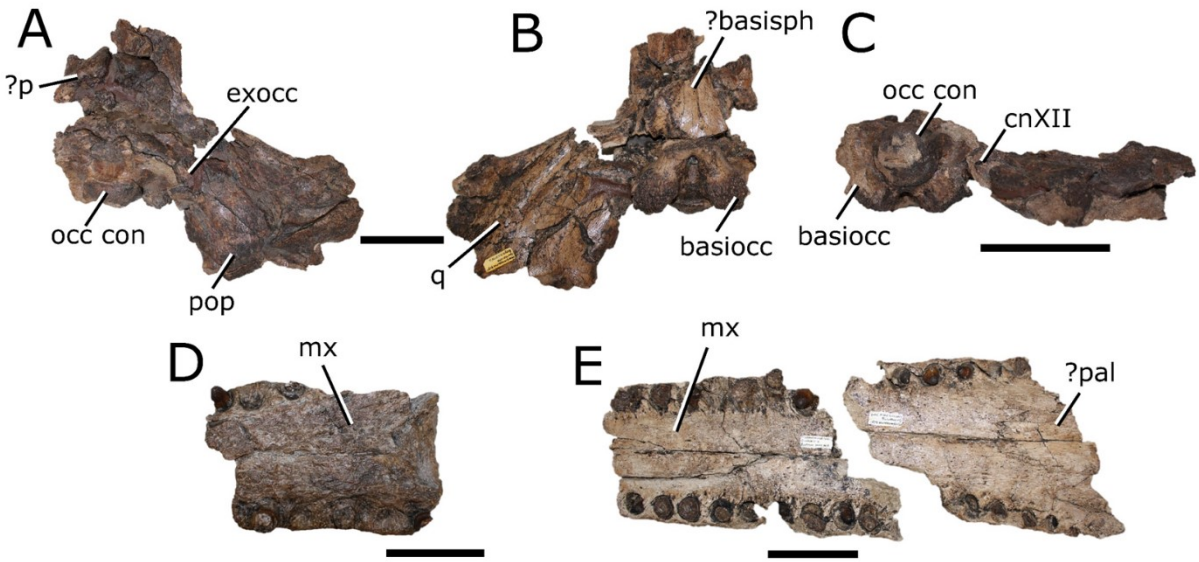


Figure 71. *Machimosaurus hugii* (von Meyer, 1837) emend. von Meyer, 1838, MG-8730, referred specimen. (A-C) MG-8730-2: occipital in (A) dorsal, (B) ventral and (C) occipital views. (D-E) MG-8730-1: partial rostrum in (D-E) palatal view. Refer to abbreviation list. Scale bars: 10 cm.

Remarks: In response to Young et al. (2014a)'s proposal that the genus *Machimosaurus* consisted of four distinct species, Martin et al. (2015) wrote a brief rebuttal, hypothesising that *Machimosaurus* was monospecific and *Mac. hugii* was the only representative of the genus. Foffa et al. (2015) then addressed the rebuttal put forth by Martin et al. (2015), noting that the authors did not address the monospecifity of *Machimosaurus* but rather concentrated on the validity of *Mac. buffetauti*, suggesting that it is the same as *Mac. mosae* and that both should be referred to *Mac. hugii* (as proposed by Martin & Vincent [2013]). Martin et al. (2015) claimed that intraspecific variation or post-mortem deformation accounted for the diagnoses put forth by Young et al. (2014a); however, while acknowledging that the specimens did undergo some deformation, Foffa et al. (2015) argued that Young et al. (2014a)'s diagnoses consisted of accurate morphological traits. In addition, both Young et al. (2014a) and Foffa et al. (2015) listed six additional factors that differentiated *Machimosaurus* species:

1. Stratigraphy;
2. Basioccipital cross-sections;

3. Comparable size and shape of basioccipital tuberosities;
4. Comparable size and lateral expansion of the paraoccipital processes;
5. Dental morphology, as well as enamel traits; and
6. Tooth counts.

Machimosaurus rex Fanti et al., 2016

(Fig. 72)

Age: Hauterivian-Barremian, Lower Cretaceous.

Locality: Touil el Mhahir, Tataouine Governorate, Tunisia.

Stratigraphic horizon: Douiret Sand Member, Douiret Formation.

Holotype: ONM NG 1-25, 80, 81, and 83-87, comprising a fragmented, partially complete skull in association with pieces of the atlas-axis complex, two complete dorsal vertebrae, multiple fragments, and isolated osteoderms and teeth.

Scoring sources: The holotype (ONM NG 1-25, 80, 81, and 83-87) was examined first-hand.

Emended diagnosis: mesorostrine skull; rostrum wider than high (shared with other members of *Machimosaurus*); conspicuous groove-ridged ornamentation along the maxilla (shared with *Mac. mosae* and *Mac. hugii*); frontal width sub-equal to orbital width (shared with the Chinese teleosauroid, *Indosinosuchus* sp., *Macrospondylus* , *Clovesuurdameredeor*, *Seldsienean*, *Deslongchampsina*, *Proexochokefalos*, *Yvridiosuchus* and *Mac. hugii*); circular orbits (shared with *Mystriosaurus*, *Indosinosuchus*, *Teleosaurus*, *Mycterosuchus*, *Clovesuurdameredeor*, *Lemmysuchus* and other members of *Machimosaurus*); parallelogram-shaped supratemporal fenestrae (shared with other members of Machimosaurini); extreme elongation of the supratemporal fenestrae (shared with other members of *Machimosaurus*); teeth large and conical with blunt apices (shared with other members of

Machimosaurini); teeth not mediolaterally compressed (shared with *Bathysuchus* and other members of Machimosaurini); carinae heterogeneous with faint denticles (shared with other members of Machimosaurini); presence of keeled carinae variable (shared with *Mac. buffetauti* and *Mac. hugii*); teeth with anastomosing pattern on the apical surface (shared with other members of Machimosaurini); pseudodenticles present (shared with *Mac. hugii*); dorsal osteoderm ornamentation consists of pits with variable size, shape and distribution (similar *Lemmysuchus*, *Mac. buffetauti* and *Mac. mosae*).

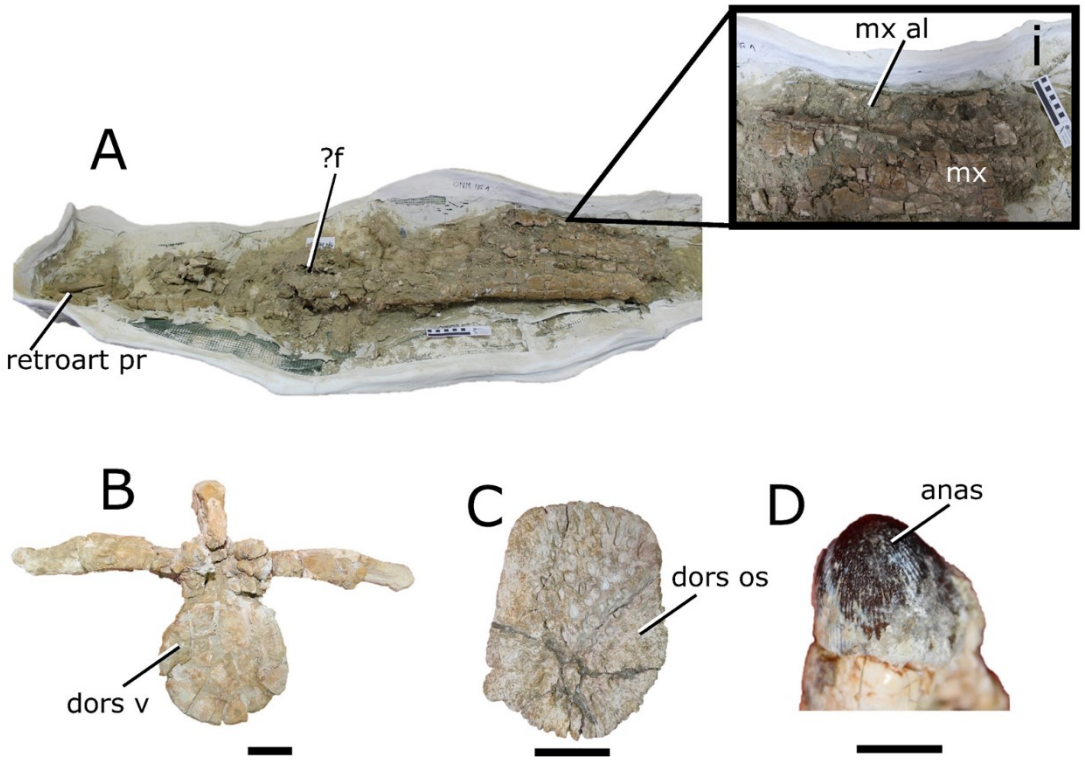


Figure 72. *Machimosaurus rex* Fanti et al., 2016, ONM NG 1-25, holotype. Partial skull in (A) ventral view, with a close-up of the (i) maxillary alveoli. Additional material: (B) dorsal vertebra in anterior view; (C) dorsal osteoderm; and (D) close-up of tooth apex. Refer to abbreviation list. Scale bars: 10 cm (as indicated on A), 5 cm (B-C) and 1 cm (D).

Remarks: While Fanti et al (2016) described this specimen as being Hauterivian in age, the exact age is unclear, due to uncertainty of the area as well as the invertebrate fauna being previously disregarded (Dridi & Johnson, in press). This is currently being investigated by J Dridi, MM Johnson and MT Young.

CLADISTIC ANALYSIS: RESULTS

Most Parsimonious Unweighted Strict Consensus: The initial New Technology search recovered 129 most parsimonious trees (MPTs) of 1619 steps (ensemble consistency index (CI) = 0.415; ensemble retention index (RI) = 0.845; ensemble rescaled consistency index (RCI) = 0.350; ensemble homoplasy index (HI) = 0.585). The 129 MPTs were combined into a single strict consensus topology (Fig. 73). With TBR branch swapping set to 100, 160 MPTs and 1619 steps were recovered; when set to 1000, 1820 MPTs and 1619 steps were found, with the best score hitting 203 out of 1000 times. The overall topology did not change, with or without TBR.

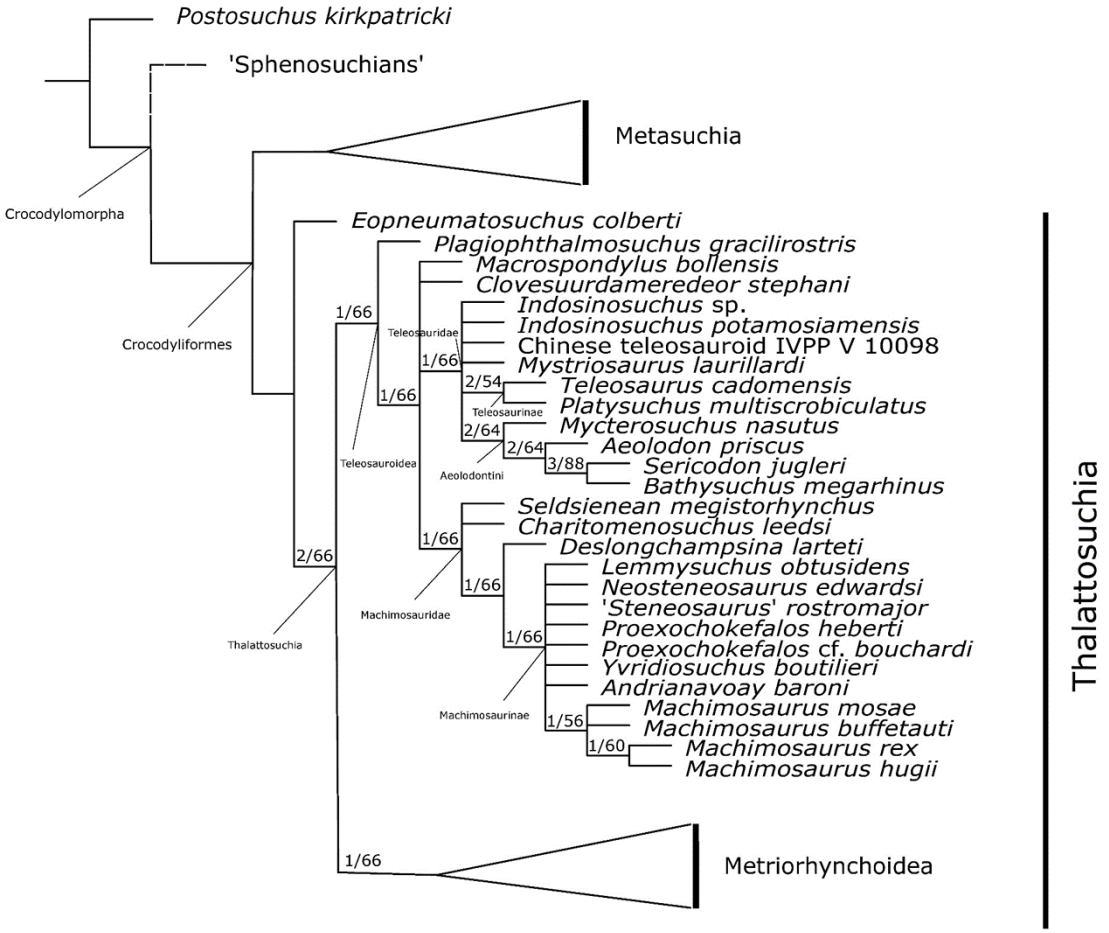


Figure 73. Results of the phylogenetic analysis, focusing on Teleosauroidea. A simplified strict consensus trees of 160 MPTs (with TBR) and 1619 steps. Teleosauroidea is monophyletic, and two distinct families (Teleosauridae and Machimosauridae) are recovered, as well as the subfamilies Teleosaurinae and Machimosaurinae, and the tribe Aeolodontini. Note that basal machimosaurins (*Yvridiosuchus*, *Lemmysuchus*) are in a polytomy with derived non-machimosaurins (*Andrianavoay*, *Neosteneosaurus*, *S.*

rostromajor and *Proexochokefalos* sp.). Bremer support and jackknife values are included (Bremer/jackknife).

In this topology, *Eopneumatosuchus colberti* Crompton and Smith, 1980, was found to be the immediate outgroup to Thalattosuchia, which was divided into two monotypic groups: Metriorhynchoidea and Teleosauroidea. Both of these clades are found to be monophyletic. Within Teleosauroidea, *Plagiophthalmosuchus* was recovered as the basal-most teleosauroid. This is weakly supported, with a jackknife percentage of 66% and a Bremer support value of 1. There are two main subclades recovered (Teleosauridae and Machimosauridae) with *Clovesuurdameredeor* and *Macrospondylus* (which together form a polytomy) being most closely related to both of them.

Within Teleosauridae (Fig. 73), *Indosinosuchus* sp., *Indosinosuchus potamosiamensis*, the Chinese teleosauroid (IVPP V 10098) and *Mystriosaurus* are unresolved with one another, and are most closely related to two remaining subgroups (labelled as Teleosaurinae and Aeolodontini; see below). The genera *Teleosaurus* and *Platysuchus* form the first subfamily (Teleosaurinae) and are each other's closest relatives, with a Bremer support value of 2 and jacknife percentage of 54%. Interestingly, the genera *Mycterosuchus*, *Aeolodon*, *Bathysuchus* and *Sericodon* form a distinct tribe (Aeolodontini). *Bathysuchus* and *Sericodon* are sister taxa (Bremer support value of 3 and jacknife of 88%); *Aeolodon* is most closely related to *Bathysuchus*+*Sericodon*; and *Mycterosuchus* is most closely related to *Aeolodon*+*Bathysuchus*+*Sericodon*.

Within Machimosauridae (Fig. 73), there are many unresolved areas. *Seldsienean* and *Charitomenosuchus* are unresolved from one another and are situated at the base of this clade (Bremer support value of 1 and jackknife of 66%). Most notably, there is a large polytomy including *Proexochokefalos*, *Pr*. cf. *bouchardi*, *Neosteneosaurus*, *Steneosaurus rostromajor*, *Andrianavoay*, *Lemmysuchus* and *Yvridiosuchus*. *Deslongchampsina* is resolved and the most closely related to this large polytomy+*Machimosaurus* group. However, when *Steneosaurus rostromajor* is removed from the analysis (189 MPTs and 1619 steps), Machimosaurini becomes a distinct group, with *Lemmysuchus*+*Yvridiosuchus* separated from

Neosteneosaurus, *Proexochokefalos*, *Pr.* cf. *bouchardi* and *Andrianavoay*. In addition, when both *Steneosaurus rostromajor* and *Andrianavoay* are removed (169 MPTs, 1619 steps), *Proexochokefalos* and *Pr.* cf. *bouchardi* are unresolved from one another but separated from *Neosteneosaurus*, which itself becomes resolved and most closely related to Machimosaurini. In all iterations (with or without the removal of *Steneosaurus rostromajor* and *Andrianavoay*), the genus *Machimosaurus* forms its own subgroup (with the large aforementioned polytomy being most closely related to it) and relationships between the four species are mostly resolved. *Machimosaurus mosae* and *Machimosaurus buffetauti* are unresolved from one another; and *Machimosaurus rex* and *Machimosaurus hugii* are each other's closest relatives (with *Machimosaurus mosae*+*Machimosaurus buffetauti* being most closely related to them).

Most Parsimonious Majority Rules: A parsimonious majority rules topology was produced to evaluate if there were any major changes from the results obtained by the strict consensus; overall, this topology (Fig. 74) is more resolved. Teleosauroidea is a monophyletic group (100% of trees find this outcome) and *Plagiophthalmosuchus* is once again found as the basal-most teleosauroid (100%). Teleosauridae (100%) and Machimosauridae (62%) are again recovered. In Teleosauridae (Fig. 74), *Indosinosuchus* sp. is situated at the base and is closely related to Teleosaurinae, Aeolodontini and an additional subclade. Aeolodontini (Fig. 74), consists of *Mycterosuchus*, *Aeolodon*, *Bathysuchus* and *Sericodon* (100%), with results similar to the strict consensus topology: *Bathysuchus* and *Sericodon* are resolved as sister taxa; *Aeolodon* is most closely related to *Bathysuchus*+*Sericodon* (100%); and *Mycterosuchus* is most closely related to *Aeolodon*+*Bathysuchus*+*Sericodon* (100%). In Teleosaurinae (Fig. 74), *Platysuchus* and *Teleosaurus* are once again each other's closest relatives (100%); In the unnamed subclade (Fig. 74), *Indosinosuchus potamosiamensis* and the Chinese teleosauroid (IVPP V 10098) are sister taxa, with *Mystriosaurus* being most closely related to them.

Machimosauridae (Fig. 74) is fundamentally more resolved when compared to the original strict consensus. *Clovesuurdameredeor* is situated

at the base of this group, in stark contrast to its initial positioning. *Seldsienean* and *Charitomenosuchus* are unresolved from one another, and Machimosaurinae (*Proexochokefalos*, *Pr*. cf. *bouchardi*, *Andrianavoay*, *Neosteneosaurus*, *Steneosaurus rostromajor* and Machimosaurini [*Yvridiosuchus*, *Lemmysuchus*, *Machimosaurus*]) is clearly defined (100%). *Deslongchampsina* is most closely related to Machimosaurinae. *Proexochokefalos* cf. *bouchardi* and *Proexochokefalos* are sister taxa, and most closely related to an unnamed subclade containing *Neosteneosaurus*+*Steneosaurus rostromajor*+*Andrianavoay*+Machimosaurini. *Neosteneosaurus*, *Steneosaurus rostromajor* and *Andrianavoay* are all unresolved from one another, and are most closely related to Machimosaurini. When *Steneosaurus rostromajor* is removed, there is no change to the topology of the tree.

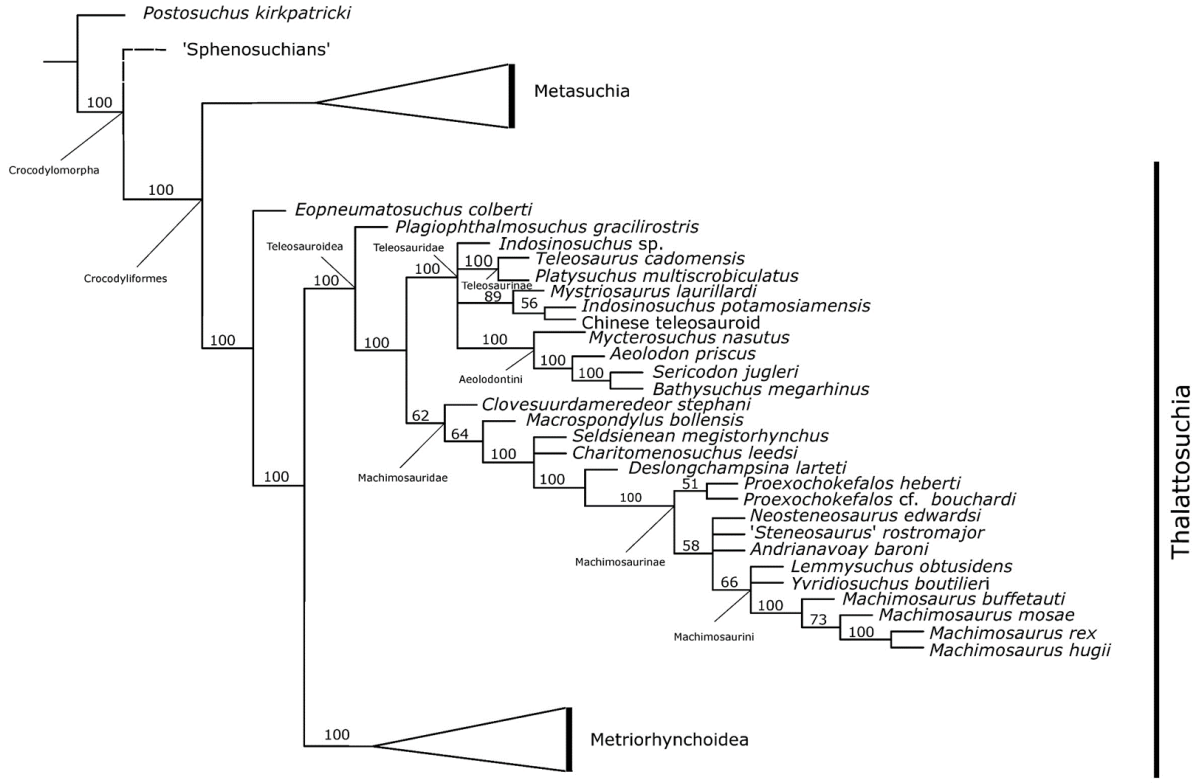


Figure 74. Results of the phylogenetic analysis, focusing on Teleosauroidea. A simplified majority rules trees of 160 MPTs (with TBR) and 1619 steps. Teleosauroidea is monophyletic and Teleosauridae and Machimosauridae are recovered, as well as Teleosaurinae, Machimosaurinae, and Aeolodontini.

Unlike the consensus topology (when all taxa are included), Machimosaurini is relatively well-supported (66%); *Lemmysuchus* and *Yvridiosuchus* (unresolved from one another) are separated from *Andrianavoay*, *Neosteneosaurus* and *Steneosaurus rostromajor* and are at the base of Machimosaurini (100%). *Machimosaurus buffetauti* and *Machimosaurus mosae* are resolved from one another, with *Machimosaurus mosae* being the more closely related to *Machimosaurus rex* and *Machimosaurus hugii* (which are sister taxa) than *Machimosaurus buffetauti*.

Weighted Strict Consensus. As outlined above, I ran the analysis once more using implied weights (k=12). I decided to run this analysis in addition to the unweighted one because implied weights are often used to improve the quality and stability of the results (Goloboff, 2014). The New Technology (all search engines tailored as above) search resulted in 56 MPTs and a score of 51.40692. Due to more stable results, this is the topology referred to when assigning names to clades (see below).

The results of the implied weighting analysis (Fig. 75) show a more resolved Teleosauroidea, similar in regards to the majority rules topology, than that seen in the original consensus. Teleosauroidea is monophyletic, *Plagiophthalmosuchus* is the basal-most teleosauroid, and the two families Teleosauridae and Machimosauridae are again well established. Teleosauridae is fully resolved (Fig. 75), in contrast to both unweighted consensus topologies. Firstly, the Chinese teleosauroid (IVPP V 10098) and *Mystriosaurus* form sister taxa (although, surprisingly, there are no synapomorphies to support this), with *Indosinosuchus* sp. (situated at the base of Teleosauridae) being most closely related to them; in the majority rules topology, *Indosinosuchus potamosiamensis* was the sister taxon to the Chinese teleosauroid (IVPP V 10098). *Teleosaurus* and *Platysuchus* are once again form Teleosaurinae; however, here they are most closely related to Aeolodontini (*Mycterosuchus*+relatives clade), which differs from the majority rules results. The positioning of *Mycterosuchus*, *Aeolodon*, *Sericodon* and *Bathysuchus* are the same as all previous results: (1) *Sericodon* and *Bathysuchus* are sister taxa; (2) *Aeolodon* is most closely related to *Bathysuchus*+*Sericodon*; and (3) *Mycterosuchus* is most closely

related to *Aeolodon+Bathysuchus+Sericodon*. *Indosinosuchus potamosiamensis* is positioned most closely related to both Teleosaurinae and Aeolodontini.

The majority of Machimosauridae is also clearly resolved (Fig. 75), with slight changes from the majority rules topology. *Macrospondylus*, rather than *Clovesuurdameredeor*, is the basal-most member of the group. *Deslongchampsina* is once again found to be most closely related to the Machimosaurinae (*Proexochokefalos*, *Pr.* cf. *bouchardi*, *Steneosaurus rostromajor*, *Andrianavoay* and Machimosaurini). *Proexochokefalos* cf. *bouchardi* and *Proexochokefalos* are sister taxa, as in the majority rules results. However, certain areas of the phylogeny remain uncertain. *Seldsienean* and *Charitomenosuchus* continue to remain unresolved from one another. Most notably, and rather surprisingly, Machimosaurini was not found to be monophyletic, more similar to the original consensus rather than the majority rules topology. *Lemmysuchus* and *Yvridiosuchus* form a polytomy with *Neosteneosaurus*, *Steneosaurus rostromajor* and *Andrianavoay* (despite many characters differentiating *Lemmysuchus* and *Yvridiosuchus* from the other taxa). However, as seen in the consensus topology, Machimosaurini is clearly defined when *Steneosaurus rostromajor* is removed (Fig. 75i), with *Yvridiosuchus+Lemmysuchus* and *Neosteneosaurus+Andrianavoay* resolved from one another. Interrelationships within the genus *Machimosaurus* were the same as the majority rules topology, with (1) *Machimosaurus hugii* and *Machimosaurus rex* as sister taxa and (2) *Machimosaurus mosae* most closely related to *Machimosaurus hugii+Machimosaurus rex* than *Machimosaurus buffetauti*.

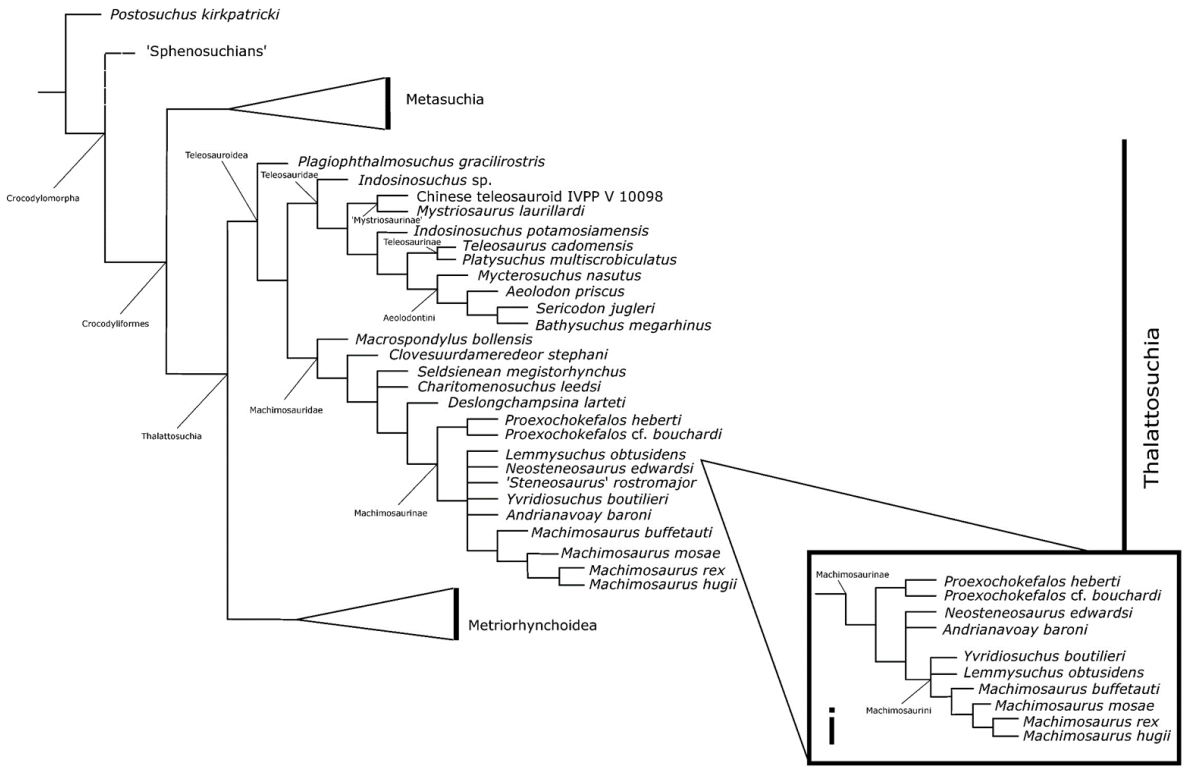


Figure 75. Results of the phylogenetic analysis, focusing on Teleosauroidea. Simplified strict consensus tree with implied weighting (k=12) of the 160 MPTs. Teleosauroidea is monophyletic and Teleosauridae and Machimosauridae are recovered, as well as Teleosaurinae, 'Mystriosaurinae', Machimosaurinae, and Aeolodontini. Note, that when (i) *S. rostromajor* is removed, Machimosaurini is recovered.

There are possible explanations as to why the tribe Machimosaurini remains unresolved from certain non-machimosaurins when all taxa are included. Firstly, both *Steneosaurus rostromajor* and *Andrianavoay* are both represented by fragmentary skull material (and therefore scored for a low amount of characters), which may contribute to the lack of resolution. Another crucial factor is the lack of postcranial material for *Andrianavoay*, *Steneosaurus rostromajor* and *Yvridiosuchus*; machimosaurins are shown to have a very distinct postcranium (e.g. Hua, 1999; Young et al., 2014a; Johnson et al., 2017). Thirdly, there are no autapomorphies observed in *Steneosaurus rostromajor*. This may contribute to the uncertainty of its placement as either an intermediate non-machimosaurin (e.g. *Neosteneosaurus*) or basal machimosaurin (e.g. *Yvridiosuchus*).

Agreement Subtrees. The agreement subtree is a function within TNT that allows the user to examine the largest subset of taxa that are identically related in all input trees (Goloboff et al., 2008). In addition, it facilitates the

identification of taxa that are likely responsible for lack of resolution or low group supports.

Using my dataset and focusing on the consensus topology, I examined the agreement subtree for Teleosauroidea (Fig. 76). *Plagiophthalmosuchus* was recovered as the basal-most teleosauroid, and Teleosauridae and Machimosauridae were resolved. In Teleosauridae, Teleosaurinae (*Teleosaurus* and *Platysuchus*) and Aeolodontini (*Mycterosuchus*, *Bathysuchus*, *Aeolodon* and *Sericodon*) were recovered. In Machimosauridae, *Macrospondylus* was situated at the base of the group. *Deslongchampsina* was most closely related to Machimosaurinae (with *Charitomenosuchus* being most closely related to *Deslongchampsina*+Machimosaurinae). Surprisingly, *Pr.* cf. *bouchardi* was recovered at the base of Machimosaurinae. *Machimosaurus rex* and *Machimosaurus hugii* were also recovered as sister taxa, and *Machimosaurus buffetauti* was most closely related to them. *Lemmysuchus* was situated at the base of Machimosaurini, with *Neosteneosaurus* most closely related to this tribe. Therefore, the taxa identified as hypothetically responsible for poor resolution (not included in the agreement tree) were *Indosinosuchus*, *Mystriosaurus*, the Chinese teleosauroid, *Clovesuurdameredeor*, *Seldsienean*, '*Steneosaurus*' *rostromajor*, *Andrianavoay*, *Proexochokefalos heberti*, *Yvridiosuchus* and *Machimosaurus mosae*. This was expected; all of the aforementioned taxa either are fragmentary, lack postcrania or are represented by a low number of specimens. As mentioned previously, these are key factors that can lead to polytomies and lack of resolution in trees. However, it is interesting to note that *Proexochokefalos* cf. *bouchardi* is included in the agreement subtree as a stable taxon, even though it is a partial skull based off specimen photographs.

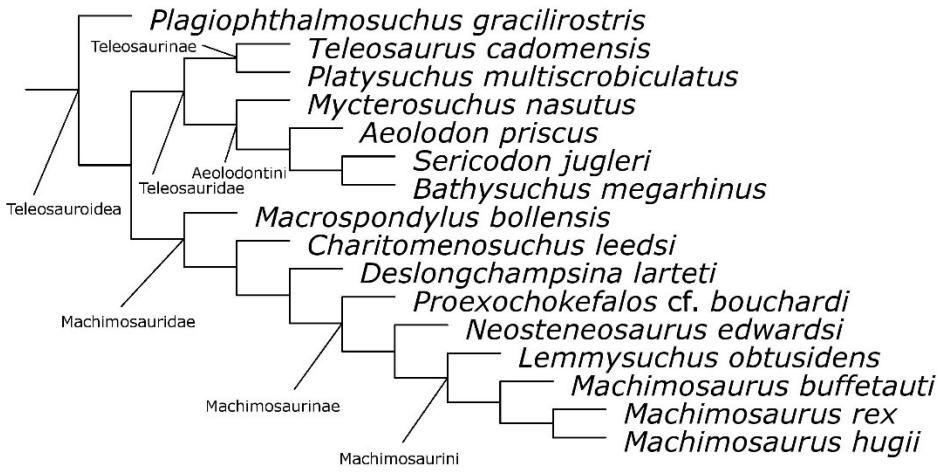


Figure 76. Agreement subtree of Teleosauroidea. Note that *Indosinosuchus*, *Mystriosaurus*, the Chinese teleosauroid, *Clovesuurdameredeor*, *Seldsienean*, *S. rostromajor*, *Andrianavoay*, *Pr. heberti*, *Yvridiosuchus* and *Mac. mosae* are the missing, suggesting that these are unstable taxa.

Bayesian Results. As mentioned previously, I ran three repetitions of MrBayes with my dataset using the following functions: (1) standard (***rates=equal***); (2), gamma distribution (***rates=gamma***); and (3) gamma distribution with variability (***1set applyto=(1) coding=variable***). The first (1) Bayesian results with equal rates are relatively similar to those found in the parsimony implied weighting topology (standard deviation = 0.009986; harmonic mean = -8051.32). Teleosauroidea is monophyletic, *Plagiophthalmosuchus* is the basal-most teleosauroid and both Teleosauridae and Machimosauridae are recovered. However, there are slight differences within both of these subclades. In Teleosauridae, Teleosaurinae (*Platysuchus* and *Teleosaurus*) is unresolved with Aeolodontini and the East Asian teleosauroids (much like in the strict consensus and majority rules topologies), and *Indosinosuchus potamosiamensis* is most closely related to the Chinese teleosauroid+*Mystriosaurus* subgroup. In Machimosauridae, *Pr.* cf. *bouchardi* and *Proexochokefalos* are not sister taxa, but rather '*Pr.*' cf. *bouchardi* is found to be most closely related to *Neosteneosaurus*+*Andrianavoay*+*Steneosaurus rostromajor*+Machimosaurini. Most interestingly, and potentially most importantly, *Steneosaurus rostromajor* is found most closely related to

Machimosaurini. In the second (2) Bayesian test (gamma distribution set as 4), the results (standard deviation = 0.009696; harmonic mean = -7747.08) are similar to that seen in the first set of Bayesian results, but with three differences: (1) *Mystriosaurus*, the Chinese teleosauroid, *Indosinosuchus* and Teleosaurinae (*Platysuchus* and *Teleosaurus*) are in a polytomy; (2) *Macrospondylus* and *Clovesuurdameredeor* are resolved, with *Macrospondylus* situated at the base of Machimosauridae; and (3) *Proexochokefalos* cf. *bouchardi* and *Proexochokefalos* are in a polytomy. The final (3) MrBayes analysis (standard deviation = 0.009853; harmonic mean = -8049.83) (Fig. 77) produced a topology similar to the secondary Bayesian results, differing in the following: (1) *Mystriosaurus*, the Chinese teleosauroid and *Indosinosuchus potamosiamensis* are unresolved with one another; and (2) *Steneosaurus rostromajor* appears to be most closely related to Machimosaurini.

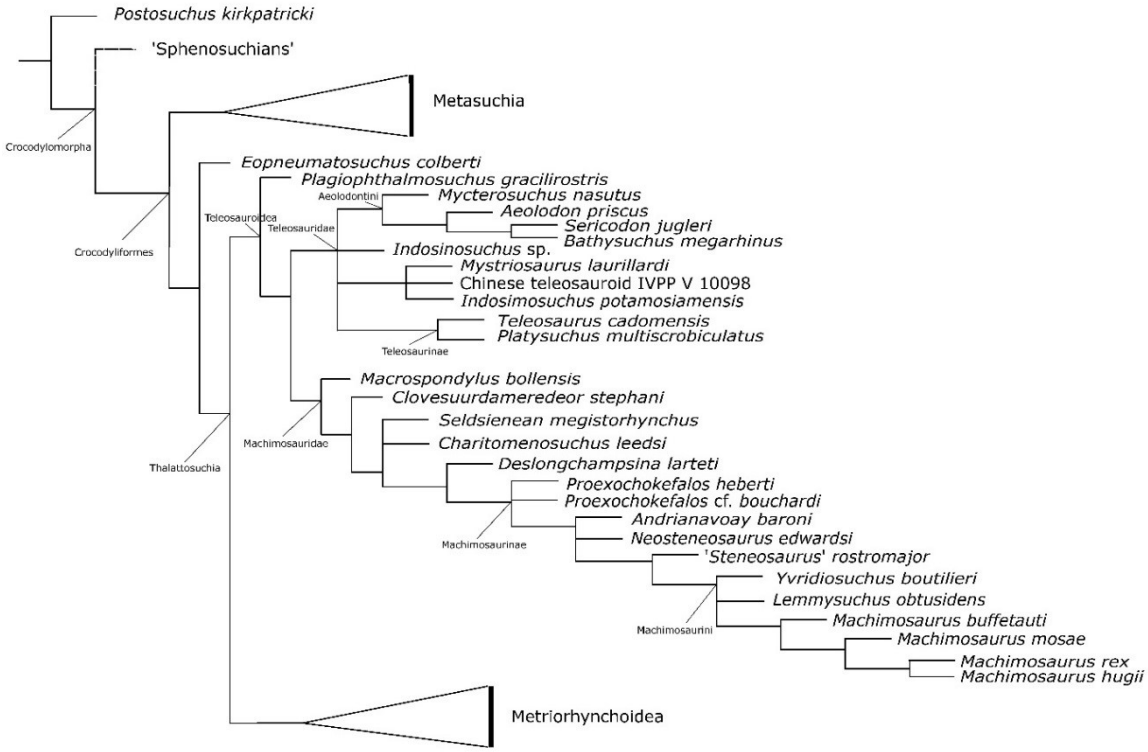


Figure 77. Simplied consensus topology, produced in MrBayes using gamma distribution with variability (***1set applyto=(1) coding=variable***).

CLADES AND THEIR SYNAPOMORPHIES

Within this section, the synapomorphies uniting major clades are highlighted and discussed. A period and then the synapomorphic character state number follow the character numbers.

Teleosauroidea

Definition. The most inclusive clade containing *Plagiophthalmosuchus gracilirostris* but not *Pelagosaurus typus*.

Definition Comment: Young & Andrade (2009) initially defined the superfamily Teleosauroidea as the most inclusive clade consisting of *Teleosaurus cadomensis*, but not *Metriorhynchus geoffroyii* von Meyer, 1832.

Synapomorphies. 47.-; 163.0; 173.0; 184.1; 203.1; 223.1; 254.2; 331.0; 402.1; 405.1; 493.0.

Comments. The superfamily Teleosauroidea is supported by multiple synapomorphies. These include absence of a sclerotic ring (163.0), postorbital medial to the jugal on the postorbital bar (173.0), straightened (sub-rectangular) anterior maxilla in palatal view (184.1), relatively reduced occipital tuberosities (203.1), paired ridges located on the medial ventral surface of the basisphenoid (223.1), a distinctly spatulate anterior dentary with the maximum width at the D3-D4 couplet (254.2), D3 occludes against the premaxillary-maxillary suture (331.0), coracoid with a fan-shape distal end and a triangular-shaped proximal end (402.1), a scapular blade as wide as or narrower than the glenoid region (405.1) and presence of caudal armour (493.0), as well as scoring the ‘pholidosaurid beak’ as inapplicable (47.-). One of these characters is new to the dataset, and another character (47) was re-written and re-scored. Certain characters score differently than *Pelagosaurus* but the same for other basal metriorhynchoids (such as *Teleidosaurus*). These include a slightly convex or flat frontal (121.0), a broadly curved anterior margin of the external mandibular fenestra (260.0), and well-defined apicobasally aligned ornamental ridges on the dentition (357.4),

Historically, teleosauroids were grouped by their 'longirostrine' skull, dorsally directed orbits and high tooth count (Geoffroy Saint-Hilaire, 1831; Karl et al., 2008; Young & Andrade, 2009; Ballell et al., 2019). However, recent studies have shown that there is more variation in the teleosauroid cranium than initially thought (e.g. Young et al., 2014a; Foffa et al., 2019; Sachs et al., 2019b), and the shape of the skull and number of teeth cannot purely be relied on to define this clade.

Teleosauridae

Definition. The most inclusive clade within Teleosauroidea containing the genus *Teleosaurus cadomensis* but not *Macrospondylus bollensis*.

Definition Comment. The family 'Teleosauridae' was originally erected by Geoffroy Saint-Hilaire (1831) and encompassed all teleosauroid taxa. However, I here restrict Teleosauridae to the following genera: *Indosinosuchus*, *Mystriosaurus laurillardi*, *Teleosaurus cadomensis*, *Platysuchus multiscrobiculatus*, *Aeolodon priscus*, *Mycterosuchus nasutus*, *Sericodon jugleri*, *Bathysuchus megarhinus* and the Chinese teleosauroid (IVPP V 10098).

Synapomorphies. 34.0; 48.1; 103.1; 158.1; 198.0; 225.0.

Comments. A number of synapomorphies supports the monophyly of Teleosauridae. These include anteriorly or anterodorsally oriented external nares (34.0), anterior and anterolateral premaxillary margins that are anteroventral and extend ventrally (48.1), supratemporal fenestrae with noticeably inclined anterior margins (103.1), postorbital overlapping the jugal (158.1) and the basisphenoid terminates at the anterior quadrates (225.0).

'Mystriosaurinae': the Chinese teleosauroid + *Mystriosaurus laurillardi*

Definition. The most inclusive clade containing *Mystriosaurus laurillardi* but not *Indosinosuchus* sp.

Comments. Interestingly, there are no synapomorphies that unite this clade, despite its stable positioning. Therefore, the subfamily 'Mystriosaurinae' is used with caution.

Teleosaurinae

Definition. The most inclusive clade containing *Teleosaurus cadomensis*, but excluding *Indosinosuchus potamosiamensis*.

Synapomorphies. 2.5; 131.1; 473.0; 480.1.

Comments. Four characters unite *Teleosaurus* and *Platysuchus* as sister taxa. These include both the tooth row and quadrate condyle being below the level of the occipital condyle but are unaligned with the tooth row at a lower level (2.5), the frontal-postorbital suture is lower than the intertemporal bar (131.1), densely distributed osteoderms with small round to ellipsoid pits (473.0), and presacral dorsal osteoderms are strongly curved (480.1). Vignaud (1995) initially diagnosed the subfamily Teleosaurinae as that containing *Platysuchus* and all *Teleosaurus* taxa. Here, *Teleosaurus* is currently limited to just one species, but follows the same proposal put forth in Vignaud (1995), in that *Platysuchus* is most closely related to *Teleosaurus*.

Aeolodontini

Definition. The most inclusive clade containing *Mycterosuchus nasutus* but excluding *Indosinosuchus potamosiamensis*.

Synapomorphies. 56.1; 230.0; 294.2; 295.1; 298.1; 299.1.

Comments. The tribe Aeolodontini, which includes the genera *Mycterosuchus*, *Aeolodon*, *Sericodon* and *Bathysuchus*, is supported by a number of synapomorphies, notably in the premaxilla. These include an '8'-shaped premaxilla in anterior view (56.1), reduced basioccipital tuberosities (230.0), laterally oriented P1 and P2 (294.2), P1 and P2 are both on the

same transverse plane (298.1) and the anterior margin between the P2-P3 is sub-rectangular, with the P3 being clearly lateral to the P2 (299.1). Four out of six characters are new to this dataset.

It is interesting in that, while similar in multiple aspects concerning the skull (namely the premaxillae), the postcranial material of *Mycterosuchus* differentiates vastly from other members of the group. For example, the proximal humerus is very strongly posteriorly deflected and hooked in *Aeolodon*, similar to members of Machimosauridae (e.g. *Charitomenosuchus*, *Neosteneosaurus*). In *Mycterosuchus*, the proximal humerus is also hooked, but weakly so and is more club-shaped. The tuberculum and articular facet of the largest dorsal ribs are positioned directly in the middle, which is more similar to *Charitomenosuchus* and opposed to the medial edge position in *Aeolodon*. Other unique postcranial features to *Mycterosuchus* include a larger ulna than radius, an elongated pubic shaft, an enlarged anteromedial femoral tuber and the calcaneal tuber being approximately 25% larger than the astragalus (as discussed above). It is likely that the unique skull characteristics of these taxa are what is continuously recovering this tribe as monophyletic.

While the postcranial remains of *Aeolodon* are well preserved in both specimens (NHMUK PV R 1086 and MNHN.F.CNJ 78), and some elements have been examined in *Sericodon* (see Schaefer et al., 2018), it is important to note that there are no postcranial bones of *Bathysuchus* currently recorded. A full, comprehensive comparison of the postcrania of *Aeolodon* and *Sericodon* is essential, to examine if *Sericodon* possesses a reduced appendicular skeleton similar to that seen in *Aeolodon*, which has been hypothesized to be more pelagic than other teleosauroids (see below, as well as Foffa et al. [2019]).

Machimosauridae

Definition. The most inclusive clade within Teleosauroidea containing *Macrospondylus bollensis* but not *Indosinosuchus* sp.

Synapomorphies. 34.1; 48.0; 103.0; 158.0; 198.1; 225.1.

Comments. The family Machimosauridae is united by a number of characters; these include the dorsally oriented external nares (34.1), the premaxillary anterior and anterolateral margins are not sub-vertical and do not extend ventrally (48.0), the premaxilla-maxilla suture is sub-rectangular and slightly interdigitating (most noticeably near the midline) (58.1), no anterolateral expansion of the supratemporal fenestrae (103.0) and the postorbital excluded from the orbit posteroventral margin (158.0).

Machimosaurinae

Definition. The most inclusive clade containing the genus *Proexochokefalos*, but excluding *Deslongchampsina larteti*.

Synapomorphies. 104.1; 269.1; 270.1; 325.0.

Comments. The subfamily Machimosaurinae is supported by a handful of characters including the supratemporal fenestra length being twice as long as the width (104.1), a shallow Meckelian groove (269.1), a sharply curved angular (270.1) and non-procumbent dentition throughout the entirety of the jaws (325.0). Two of these characters are new to the dataset.

Unnamed Clade: *Proexochokefalos heberti* + *Proexochokefalos* cf. *bouchardi*

Definition. The most inclusive clade containing the genus *Proexochokefalos*.

Synapomorphies. 66.0.

Comments. The sole character supporting *Proexochokefalos heberti* and *Proexochokefalos* cf. *bouchardi* as sister taxon is the lack of a midline cavity (=trench) on the nasals, instead being flat (66.0).

Machimosaurini

Definition. The most inclusive clade containing *Yvridiosuchus boutilieri* but not *Neosteneosaurus edwardsi* or *Steneosaurus rostromajor*.

Definition Comment: Jouve et al. (2016) initially defined the tribe Machimosaurini based on the following features that characterize this group: shortened rostra; enlarged supratemporal fenestrae; reduced tooth counts; and blunt, ornamented dentition.

Synapomorphies. 102.5; 327.1; 345.0; 349.2; 351.2; 352.1; 353.1; 358.1; 379.1; 449.1; 464.1; 473.3.

Comments. A number of character states supports the monophyly of the tribe Machimosaurini. These include parallelogram-shaped supratemporal fenestrae (102.5), blunt apices (327.1), no curvature in the middle to posterior dentition (345.0), rounded true denticles (352.1), strongly developed anastomosed pattern on the apices (358.1), three sacral vertebrae (379.1), sub-square ischial plate (449.1), ventrally angled tibial tuberosity (464.1), and keeled osteoderms with variable, elongated pits (473.3). Two of these characters are new to the dataset.

Certain characteristics of machimosaurins, particularly their teeth, have been well noted for many years, ever since *Machimosaurus hugii* was first described by von Meyer in 1837, who made a particular comment about the dentition: "*…stumpfkonischen und dicht gestreiften Zähnen besonders charakteristisch herauszustellen…*" ("…particularly [conspicuous in] conical and densely striped teeth...") (von Meyer, 1837: 560). Sauvage and Liénard (1879: 7) noted "*La forme des vertèbres, la disposition des écussons, la composition de la tête […], la forme et l'ornamentation des dents…*" ("The shape of the vertebrae, the arrangement of the osteoderms, the composition of the head […], the shape and ornamentation of the teeth…") when describing *Machimosaurus mosae*. Phillips (1871: 184-185) also defined the teeth of *Yvridiosuchus* (then known as *Teleosaurus brevidens*; see Johnson et al., 2019) as "…rather short [teeth]…a little curved, uniformly striated, the striae growing more prominent toward the point and finer toward the base…

[a] slight trace of bicarination on these teeth, near the apex, which is usually blunt…"; he appears to be referring to the anastomosing pattern here. Andrews (1913: 132), made note of the third sacral vertebra in *Lemmysuchus*, saying "…a remarkable condition is found, there being apparently three sacrals… [seems to be] that the ribs of the first caudal have greatly enlarged and resemble sacral ribs…" (Andrews [1913], however, thought this to be a unique feature in *Lemmysuchus*, thus not taking into context the same condition seen in members of *Machimosaurus*).

Recent papers have also highlighted several of these features, including detailed descriptions of the dentition (Young & Steel, 2014; Young et al., 2015; Jouve et al., 2016), specific features of the skull (Hua, 1996; Young et al., 2014a; Fanti et al., 2016; Johnson et al., 2017; Johnson et al., 2019), the reduction in the pelvic bones (Johnson et al., 2017) and the sacral anatomy (Martin & Vincent, 2013; Young et al., 2014a; Johnson et al., 2017).

Features uniting the genus *Machimosaurus*

Definitive Synapomorphies. 7.0.

Ambiguous Synapomorphies. 32.0; 288.3; 292.-; 293.-; 294.-; 297.-; 300.-; 395.{01}; 406.1.

Comments. There are multiple features unique to the genus *Machimosaurus*; however, there is only one definitive character that is preserved in all species, a wider than higher rostrum (7.0). The remaining characters are found in both *Mac. buffetauti* and *Mac. mosae*, but are scored as (?) in *Mac. hugii* and *Mac. rex* due to lack of or fragmentary material. Therefore, these are noted as ambiguous synapomorphies. They include simple, straight-lined dentary neurovascular foramina (32.0), three premaxillary alveoli (288.3), the tuberculum and articular facet of dorsal ribs positioned halfway in the middle (395.{01}), scapula with a strongly concave anterior edge (406.1), and inapplicability of ch. 292 to 294, 297 and 300.

AREAS OF UNCERTAINTY

The current analysis, in similarity with more recent studies (e.g. Ősi et al., 2018; Foffa et al., 2019; Johnson et al., 2019; Sachs et al., 2019b), finds certain aspects of the phylogeny to continuously be consistent. Most notably, these include the recoveries of (1) *Plagiophthalmosuchus* as the basal-most teleosauroid; (2) two families (Teleosauridae and Machimosauridae); and (3) the tribe Machimosaurini within Machimosauridae. In addition, the recovery of Teleosaurinae and Aeolodontini in the current analysis are also consistent, regardless of differing phylogenetic tests conducted. However, the positioning of remaining taxa continues to be variant. The taxon *Proexochokefalos* cf. *bouchardi* is an example: in the consensus results, it is recovered as unresolved with other members of Machimosaurinae; in the majority rules and implied weighting topologies, it is recovered as the sister taxa to *Proexochokefalos*; and in the equal rates Bayesian test, it is found separate from *Proexochokefalos* and most closely related to *Andrianavoay*, *Neosteneosaurus*, *Steneosaurus rostromajor* and Machimosaurini.

With these degrees of uncertainty, the addition of new characters and teleosauroid taxa has only caused greater ambiguity in certain areas of the tree (especially in the unweighted consensus analysis). While it is undoubtedly important to carefully study, reanalyse and re-describe specimens, and discover new character data, the addition of new characters may not be the key in resolving these issues. More importantly, one of the major problems lies in the fact that a single specimen represents many of these species. In some cases, these are well preserved and offer vital information (e.g. *Proexochokefalos*), but on the other hand there are certain ones that may be key intermediate forms, but are too fragmentary to offer any substantial information (e.g. *Andrianavoay*). One contributing factor is that very little fossil prospection is taking place in localities where these specimens have been found (e.g. Toarcian outcrops in China, Bathonian locations in Madagascar, Late Jurassic sites in Thailand). In addition, there are vast areas, particularly along the Gondwanan coasts of Africa and India, which have yielded promising material but have yet to be prospected properly (Dridi & Johnson, in press). The discovery of additional material, as well as

new taxa with unique characters, will offer a greater resolution into teleosauroid evolution over the Jurassic.

EXCLUDED TAXA

All teleosauroid taxa used and described in the study were carefully considered and discussed at the beginning of this dissertation work. However, several known species were excluded for a variety of reasons.

Certain taxa were omitted as the holotype was either destroyed or could not be located, and said taxa did not possess any other current substantial material. This is a common trend, particularly for 19th Century European specimens, for the holotype or available material to become lost or missing. For example, *Machimosaurus nowackianus*, a specimen comprising of the anterior dentary from Ethiopia, was reported being housed in the GPIT in Tübingen (Young et al., 2014a). However, multiple researchers attempted to locate it within the collection and were unable; I was also not able to find it during my visit to GPIT (although it has currently been reported as returned from loan in March of 2017: R. Irmis, pers. comm.). It is therefore presumed to be missing, misplaced or stolen. There is one available photo of the specimen (Young et al., 2014a, from Huene 1938 fig. 1–4) (Fig. 78A); however, it was only shown in a slightly blurred dorsal view, but more importantly, due to the sheer incompleteness of the specimen and lack of characteristic features, we omitted this taxon from the dataset. The taxon '*Steneosaurus deslongchampsianus*' Lennier 1887 (Fig. 78C), was also excluded from the dataset because the holotype (comprising of skull material and one mandible) was destroyed in 1944; in addition, there was no substantial material for this particular taxon reported in any museum I visited or contacted, and line drawings are currently the only source of information available (see Savalle, 1876; Lennier, 1887). While these are invaluable for research, I was wary to score an entire 'taxon' using only drawings; there are many instances, especially during the 19th and early 20th centuries, where figures were either altered, drawn to include missing skeletal elements, or interpreted as similar to other taxa (e.g Andrews, 1913). The holotype of

Teleosaurus geoffroyi Eudes-Deslongchamps, 1868d was based off three mandibular fragments, which J.A. Eudes-Deslongchamps considered distinct due to *"…un nombre sensiblement inférieur de dents*" ("…a significantly lower number of teeth") than *T. cadomensis* (Vignaud, 1995: 181). However, this specimen (now considered an objective junior synonym of *T. cadomensis*) was also destroyed in 1944, and this distinguishing feature cannot be confirmed.

Certain taxa were disregarded due to specimens simply being too fragmentary for thorough taxonomic verification. For example, the holotype of '*Steneosaurus*' *rudis* Sauvage, 1874 consisted of fragmentary pieces of the skull and mandible; it was part of the BHN2R collection, which was later closed in 2003, and it went missing. However, Vignaud (1995) suggested that, due to the robustness of the specimen, it could be referred to as *Machimosaurus* sp. Another example is '*Steneosaurus*' *roissyi* Eudes-Deslongchamps, 1869 (MNHN.RJN 130a-c) (Fig. 78B), which consists of a fragmentary piece of the mandible; this material has no distinguishing characteristics, and is therefore more apt to be referred to as Teleosauroidea indeterminate.

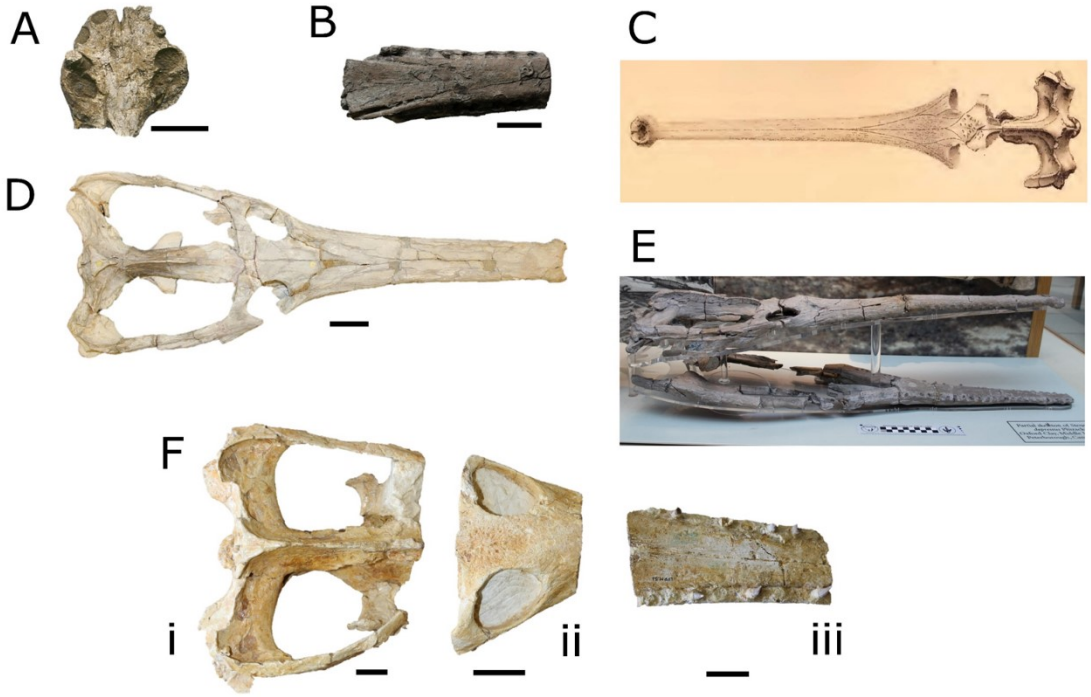


Figure 78. Taxa excluded from the current H+Y dataset, including: (A) *Machimosaurus nowackianus* (taken from Young et al., 2014a: Figure 3); (B) '*Steneosaurus*' *roissyi* (MNHN.RJN 130a-c); (C) '*Steneosaurus*' *deslongchampsianus* (Savalle, 1876: pl. IIIa); (D) '*Steneosaurus*' *hulkei* (NHMUK PV R 2074); (E) '*Steneosaurus*' *depressus* (OUMNH J.01420); and (F) '*Steneosaurus*' *pictaviensis* (LPP.M.37). Scale bars: 4 cm (A-B, D, Fii) and 2 cm (Fi and iii).

Three teleosauroid taxa with a considerable amount of material were not included in my analysis. The first is '*Steneosaurus*' *pictaviensis* Vignaud, 1998 (Fig. 78F). Vignaud (1998) described the holotype (LPP.M.35; although this specimen is labelled as LPP.M.37 in collections) and paratype (LPP.M.37, although this is labelled as LPP.M.35 in collections) as being different from '*Steneosaurus*' (*Charitomenosuchus*) leedsi in that: (1) no antorbital fenestra (only an underlying depression) was present in '*S. pictaviensis*'; (2) the maxillae were "*plus élevés*" ("higher than") '*S.*' *leedsi*; and (3) the interalveolar surface of the dentary was smooth and "*sans les deux sillons longitudinaux*" ("without the two longitudinal furrows") as in '*S.*' *leedsi*. However, these characters are inaccurate; firstly, in *C. leedsi* (NHMUK PV R 3320; NHMUK PV R 3806; BRLSI GP1770a-e), the antorbital fenestrae are depression-like, as they are very small and relatively shallow. In LPP.M.37, there is a small depression where the antorbital fenestrae

should be located, similar to *C. leedsi*. Secondly, the crania of many *C. leedsi* specimens (e.g. NHMUK PV R 3320; NHMUK PV R 3806; PETMG R179) are dorsoventrally crushed, so the maxillae appear to be low; however, BRLSI GP1770a-e is relatively well preserved, with the maxillae dorsoventrally high as in LPP.M.37. Lastly, it is unclear what 'longitudinal furrows' Vignaud (1998) was referring to in *C. leedsi*; the interalveolar surface of the dentary (NHMUKL PV R 3320; NHMUK PV R 3806) is smooth with lateral crenulations more prominent in the anterior region similar to LPP.M.35. If Vignaud (1998) was referring to the coronoid processes protruding into the dentary, these are quite large in both LPP.M.35 and *C. leedsi* (NHMUK PV R 3320). In addition, LPP.M.35 and LPP.M.37 are similar to *C. leedsi* (NHMUK PV R 3320; NHMUK PV R 3806) in the following:

1. Frontal with few, circular pits mainly concentrated in the centre of the bone;
2. Mediolaterally thin posterior processes of the nasals;
3. Subrectangular supratemporal fenestrae;
4. Multiple slender teeth with pointed apices; and
5. All referred specimens are middle Callovian in age, and are found in the corresponding stratigraphic horizons.

Therefore, I currently refer '*S. pictaviensis*' to *C. leedsi*. The second taxon is '*Steneosaurus*' *depressus* Phizackerley, 1951 (OUMNH J.01420) (Fig. 78E), which was diagnosed based on: (1) the delicately constructed skull; (2) a slender, rounded rostrum comprising 64% of the total skull length; (3) small orbits; (4) small, slender, curved teeth; and (5) mandibular symphysis occupying roughly 48% of the entire mandible (Phizackerley, 1951). However, this taxon shares the following combination of key characteristics seen in *Proexochokefalos* (MNHN.F 1890-13):

1. Enlarged occipital tuberosities (differs from all other members of Teleosauroidea);
2. No antorbital fenestrae;
3. Elongated, slender anterior process of the jugal; and
4. The P1 is oriented anteriorly and the P2 is oriented slightly medially (differs from *Neosteneosaurus* NHMUK PV R 3701).

Therefore, I tentatively refer to '*S.*' *depressus* as a junior synonym of *Proexochokefalos heberti*. However, a thorough re-description of both specimens is needed and is beyond the scope of this manuscript.

The final taxon, '*Steneosaurus*' *hulkei* (NHMUK PV R 2074) (Fig. 78D), was excluded from the dataset as it represented a sub-adult individual. The vertebral neurocentral suture is visibly prominent in young modern crocodilians and gradually closes and disappears in adults, in the direction from the caudals to the cervicals (Brochu, 1996). In '*S.*' *hulkei*, the neurocentral suture is visible and well-developed in the posterior thoracic vertebrae, suggesting it was a juvenile or sub-adult. In addition, '*S.*' *hulkei* displays certain features similar to those seen in *Neosteneosaurus* (NHMUK PV R 2865; PETMG R178) and differs from *Charitomenosuchus* (NHMUK PV R 3320, NHMUK PV R 3806) and *Lemmysuchus* (NHMUK PV R 3168), such as:

1. Cranium is overall more robust than *Charitomenosuchus* (NHMUK PV R 3320);
2. No antorbital fenestrae (differs from *Charitomenosuchus* [NHMUK PV R 3320, NHMUK PV R 3168] in which they are present);
3. A subcircular premaxilla-maxilla suture (differs from *Charitomenosuchus* [NHMUK PV R 3320] which has a strongly interdigitating, rectangular premaxilla-maxilla suture);
4. Dorsoventrally short supraoccipital (differs from *Lemmysuchus* [NHMUK PV R 3168] in which the supraoccipital is dorsoventrally tall);
5. Deep reception pits until the posterior region (differs from *Charitomenosuchus* [NHMUK PV R 3806] which has deep reception pits until the mid-maxilla, and *Lemmysuchus* [NHMUK PV R 3168] which has deep reception pits along the entirety of the maxilla);
6. Straightened posteriorly-placed cervical ribs (differs from *Lemmysuchus* [NHMUK PV R 3168] which has a curved posteriorly-placed cervical rib);

7. Triangular-shaped ischial blade and elongated anterior iliac process (differs from *Lemmysuchus* [NHMUK PV R 3168] in which the ischial blade is sub-square and the anterior iliac process is shortened); and
8. Two sacral vertebrae (differs from *Lemmysuchus* [NHMUK PV R 3168] which has three sacrals).

Therefore, '*S.*' *hulkei* is referable to the taxon *Neosteneosaurus*.

CHAPTER V:

Teleosauroid Evolutionary Implications through Time

"…the important office of controlling the excessive increase of the aquatic herbivora appears to have been consigned to the Crocodile, whose habits fitted them, in a peculiar degree, for such a service."

- W. Buckland (1836: 251)

PREFACE: I was responsible for all the work carried out in this chapter, including the comparisons, interpretations and figures.

IMPLICATIONS INTO TELEOSAUROID EVOLUTION

This chapter explores the evolutionary history of teleosauroids, focusing on their species richness, ecomorphology and global distribution. The phylogeny previously provided an explicit framework for the interpretation of teleosauroid evolution as well as biogeographical and ecological distribution. However, it does not offer an immediate insight into the early evolution of this clade. *Plagiophthalmosuchus*, the basal-most teleosauroid, first appeared during the early Toarcian (Early Jurassic) and is remarkably similar in certain morphological aspects to *Pelagosaurus typus*, the current basal-most metriorhynchoid. These features include an elongated, slender rostrum, a larger antorbital external fenestra than internal fenestra and laterally directed orbits (Fig. 1). Due to similar characteristics, they likely lived in comparable habitats, particularly shallow marine environments. However, along with its metriorhynchoid-like features, *Plagiophthalmosuchus* already displays purely teleosauroid characteristics, including: paired ridges on the medioventral surface of the basisphenoid; a distinctly spatulate anterior dentary; and a scapular blade nearly as wide as the glenoid region.

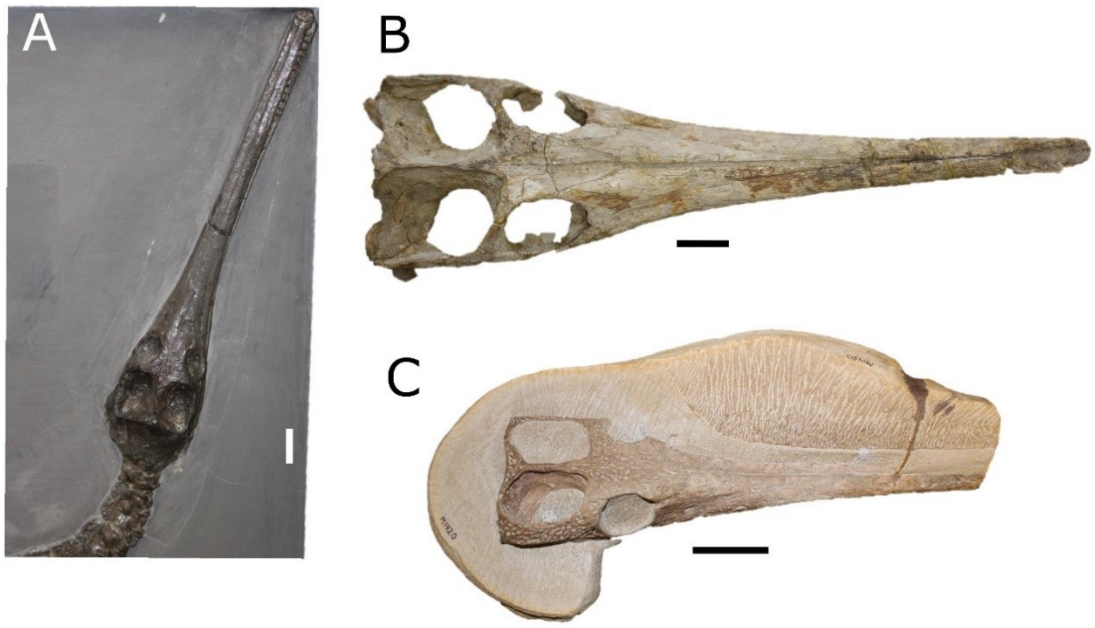


Figure 1. Comparative photographs of (A) *Plagiophthalmosuchus* (NHMUK PV OR 14792) and the basal metriorhynchoid *Pelagosaurus* ((B unnumbered MUHNAC specimen; (C) BRLSI M.1420). Scale bars: 5 cm.

These distinctive features seem to appear almost unexpectedly out of nowhere; it is therefore difficult to discern the immediate ancestor of Teleosauroidea and when exactly this group first originated (this is also hampered by the fact that the immediate predecessor to Thalattosuchia is currently unclear). Nevertheless, during the Toarcian (~189.6 to 180.1 million years ago [mya]), teleosauroids were abundant throughout Britain and Europe (particularly in Germany, Luxembourg and France). During this time, they also spread into eastern Asia (although these taxa are admittedly rarer). Teleosauroids were already surprisingly diverse in the Toarcian, with representatives from both Teleosauridae (*Platysuchus*, *Mystriosaurus*, the Chinese teleosauroid) and Machimosauridae (*Macrospondylus*) present in addition to *Plagiophthalmosuchus*. How they were able to diversify and expand so quickly has only recently been questioned; during this time in the Toarcian, there were no other major macro-faunae groups inhabiting these swampy, coastal environments, as previous residents such as phytosaurs (Morales & Ash, 1993; Stocker & Butler, 2013) and metoposaurid temnospondyls (Brusatte et al., 2015) had gone extinct during the end of the Triassic. It is possible that, due to this sudden habitat availability, basal teleosauroids (as well as basal metriorhynchoids) were able to rapidly spread

into and dominate these areas, in part due to their semi-marine adaptations (Krebs, 1962; Westphal, 1962; Buffetaut et al., 1981).

While *Plagiophthalmosuchus* was a less common figure during the Toarcian, *Macrospondylus* was an extremely abundant taxon; hundreds of specimens have been collected, particularly from *lagerstätte* deposits (namely the Posidonia Shale Formation) in Germany. This shows that the relatively 'primitive' machimosaurid body plan was already extremely successful, and *Macrospondylus* was able to expand and flourish within coastal and/or lagoon environments. *Mystriosaurus*, a more robust, shorter snouted form than either *Macrospondylus* or *Plagiophthalmosuchus*, was a relatively uncommon taxon from both Britain and Europe. However, ongoing work is discovering more *Mystriosaurus* specimens that were originally classified as '*Steneosaurus*' *bollensis*; it appears as though this taxon was more abundant than initially thought, although not nearly to the extent as *Macrospondylus*. The genus *Platysuchus*, characterised by five premaxillary alveoli and an extremely integrated dorsal shield, represented a rarer taxon, known from select localities in Europe (specimens have currently only been found from the Posidonia Shale Formation in Germany and *Harpoceras serpentinum* ammonite Zone in Luxembourg). In addition to *Platysuchus*, the Chinese teleosauroid IVPP V 10098 (previously referred to as *Peipehsuchus teleorhinus*; Li, 1993) from the Lower Jurassic of the Ziliujing Formation of China, is an incredibly rare taxon and is currently represented by only one specimen (IVPP V 10098) (although this specimen scarcity may be due to the fact that this area of the Sichuan Basin is largely unexplored; Li et al., 2011). This teleosauroid is remarkably anatomically different when compared with other Toarcian taxa, including having a strongly mediolaterally elongated premaxillae, giving the anterior snout a 'beak'-like appearance in dorsal view; protruding orbits; and poorly ornamented skull. These unique features in the Chinese teleosauroid again highlights both the extraordinary diversity of basal teleosauroids during the early stages of their evolution and their exceptional ability to adapt to different environments. The genus '*Teleosaurus*' (grouped into the genus *Peipehsuchus*; Young, 1964) has also been reported from the lower Tzeliuching (Ziliujing) Formation in China (Liu, 1961); the specimen consists of fragmentary osteoderms. A potential sixth

teleosauroid taxon, represented by a partial rostrum, has been recorded from Luxembourg (Johnson et al., 2018), with the characteristic presence of three premaxillary alveoli (which is only present in the genus *Machimosaurus*). More specimens need to be found and examined to definitively assign a genus to this taxon, as it is currently classified as Teleosauroidea indeterminate (Johnson et al., 2018); however, a teleosauroid specimen on display at the Manchester Museum (MANCH) may potentially have this character.

One hypothesis for this difference in relative species abundance in the Toarcian teleosauroids is that *Plagiophthalmosuchus*, *Platysuchus* and the Chinese teleosauroid were more specialized than *Macrospondylus* and *Mystriosaurus*, and therefore more restricted to certain ecological niches. *Plagiophthalmosuchus* displays morphological features suggesting a piscivorous nature (e.g. lateral orbits, multiple small thin teeth; see below), whereas *Platysuchus* has certain postcranial features (e.g. tightly integrated dorsal shield, stocky forelimb) that, while not specifically related to feeding, may limit the potential habitat in which it lived. The unique, and frankly bizarre, anatomical features of the Chinese teleosauroid (as highlighted above) indicate that it must have been particularly specialized for a certain niche; in fact, it has been suggested that this taxon inhabited (or frequented) freshwater environments (Martin et al., 2016) as the Ziliujing Formation originates from lacustrine deposits (Wang et al., 2008). In contrast, *Macrospondylus* and *Mystriosaurus* display characteristics that suggest a more generalist lifestyle, both in terms of feeding and habitat (e.g. dorsally directed external nares, dorsal orbits). This categorization can be seen in modern crocodilians; gharials are specialized for piscivory and small compliant prey (Erickson et al., 2012), exhibit unique anatomical features (e.g. Martin & Bellairs, 1977; McCurry et al., 2017), and are restricted to freshwater rivers in the northern Indian subcontinent. In contrast, the American alligator (*Alligator mississippiensis*) and some crocodiles (e.g. *Crocodylus porosus*) are more opportunistic in terms of feeding and habitat (Erickson et al., 2012) have a generalized body plan, and cover wide ranges with the ability to move freely between these areas. Another more tentative theory may be that, due to the relatively larger sizes of both *Mystriosaurus*

and *Macrospondylus* (some skulls of *Macrospondylus* are measured to be nearly 1 m in total length), they were able to outcompete *Plagiophthalmosuchus* or *Platysuchus* for potential food resources (McDonald, 2002), thus influencing their abundance. This plays upon Hutchinson's (1959) idea that if similar species are to coexist, then there must be trophic minimum ratios between them.

For unknown reasons, there is very little teleosauroid material from the Aalenian and Bajocian (~180 to 169 mya), which presents a major gap in understanding teleosauroid evolution. The material collected mainly consists of undiagnostic fragments, and are generally attributed to '*Steneosaurus*' sp. (e.g. Efimov, 1978, 1982, 1988; Storrs & Efimov, 2000; Čerňanský et al., 2017). While there is little that can be gleaned from them morphologically, biogeographically they are important (see below). The most complete material known from either period is a partial '*Steneosaurus*' skull from the Aalenian, reported by Efimov (1988) and housed at the Grozny Petroleum Research Institute (GrozNII) in the Chechen Republic; however, this specimen has been destroyed due to military conflict in the area (S. Zaurbekov, pers. comm.). In addition, the genus *Teleosaurus* has been recorded from the lower Shaximiao Formation in China (He, 1984; Li et al., 2011), which is described as being Bajocian to Callovian in age (Li et al., 2011). However, the exact period in which this specimen was found is unknown; the specimen itself (He, 1984) may also belong to Testudines, but the photographs are too dark to confirm whether it is teleosauroid or turtle.

While the Aalenian-Bajocian is poorly understood, there are many teleosauroid species reported from the Bathonian (~169.2 to 164.4 mya). One major evolutionary marvel during this time is the sudden appearance of representatives from Machimosaurini: big-headed, blunt-toothed teleosauroids that evidently fed on different prey items and occupied a drastically different ecological role than any of the aforementioned Toarcian taxa. The large crania of machimosaurins allowed for massive muscles with strong attachment points for closing of the jaws (Johnson et al., 2017), and the conical, blunt, ornamented teeth allowed for feeding on harder bodied prey, such as hard shelled or thick scaled organisms (Young et al., 2014a).

Due to these cranial features, this group has been regarded as durophagous/macrophagous; *Machimosaurus* in particular is thought to be chelonivorous (feeding on turtles), as several Plesiochelyidae shells from the Solothurn Turtle Limestone in Switzerland have either *Machimosaurus* bite marks or *Machimosaurus* teeth embedded in them (Meyer, 1991; Jank et al., 2006; Young et al., 2014a). The currently first known definitive representative of Machimosaurini (Bathonian in age), *Yvridiosuchus*, is a somewhat common taxon found in both Britain and France, with specimens consisting of skulls and/or mandibles (currently, no postcranial bones have been attributed to this genus). Additional machimosaurin material, although fragmentary and currently undiagnostic, is present in northern Africa (Fara et al., 2002; Jouve et al., 2016), highlighting that this subclade was a well-established and widespread group. Other non-machimosaurin genera were also present during this time; multiple specimens, particularly from France, represent the genus *Teleosaurus*, highlighted by its immensely integrated dorsal shield, similar to that seen in the Toarcian *Platysuchus*. Three relatively rarer forms are represented by *Deslongchampsina*, *Seldsienean* and *Clovesuurdameredeor*; in biogeographical terms, they are more restricted than *Yvridiosuchus* (*Clovesuurdameredeor* in Britain; *Deslongchampsina* and *Seldsienean* in Britain and France). While *Deslongchampsina* is highlighted by a unique suite of cranial and dental characteristics (e.g. robust, pointed teeth; poorly constricted premaxillae; large antorbital fenestrae), *Clovesuurdameredeor* retains a relatively basal form, in some ways similar to *Macrospondylus*. Fragmentary *Seldsienean* material suggests that it possessed slender, longirostrine jaws. In addition, *Andrianavoay* from Madagascar is also rare (possibly due to limited prospection in the area) but is an important taxon when examining anatomical variation between machimosaurins and closely related non-machimosaurins, as well as teleosauroid dispersal patterns. Unfortunately, the material of the currently only known specimen is fragmentary, with many important cranial features not preserved.

There is a multitude of teleosauroid specimens known from the Callovian (~164.4 to 159.4 mya), particularly the Peterborough area in Britain. Two factors play an important part in why there is an abundance of

fossils from this area: (1) preservation bias (as the Oxford Clay Formation (OCF) in England has an excellent record of preserving fossils); and (2) the 'clay rush' of the 19th Century. Nevertheless, this period could be considered a 'golden age' for teleosauroid evolution, as they continued to dominate coastal environments, both in numbers and morphological diversity (the latter more so than the Toarcian). Four distinct taxa are currently known: the first is *Neosteneosaurus*, an intermediate, large bodied form that is near common as *Macrospondylus* in the Toarcian. This is currently the largest known teleosauroid in the OCF (Johnson et al., 2015; Young et al., 2016; Johnson et al., 2017), with a total body length estimate of between 660 and 667 cm. This teleosauroid exhibits a subtle type of heterodonty (two different types of teeth), as the anterior teeth are slenderer and more pointed than the posterior ones. In fact, the posterior-most teeth are almost conical (e.g. PETMG R 178), similar to the dentition seen in *Lemmysuchus*, but retain a subtly pointed apex and do not possess an anastomosing pattern. The second form is represented by *Charitomenosuchus*, a slender-skulled, gracile teleosauroid that was relatively common but not to the extent as *Neosteneosaurus*. The remaining two taxa, *Lemmysuchus* and *Mycterosuchus*, are relatively rarer genera found from both Britain as well as Europe (*Lemmysuchus* in France, and *Mycterosuchus* in Germany). *Lemmysuchus* is a representative of Machimosaurini, as indicated by the enlarged supratemporal fenestrae and blunt, anastomosed teeth. One intriguing feature about *Lemmysuchus* is the reduction of the pelvic bones, including a shallow acetabulum and supraacetabular crest, sub-rounded ischial blade, and stocky anterior iliac process. This suggests that *Lemmysuchus* was well adapted for living in higher energy environments, which has not been seen in any earlier teleosauroids.

The bizarre *Mycterosuchus* possesses another salient combination of features, including: an extremely elongate, slender, and heavily ornamented skull; protruding orbits; an elongated humerus, ulna and pubis; massive neural spines that are similar in height in the posterior cervical and anterior thoracic vertebrae; large calcaneum; and curved, slightly 'W'-shaped pits on the dorsal osteoderms. *Proexochokefalos heberti*, a taxon currently known to be endemic to France (although it may have been present in Britain, as

discussed above), was also relatively rare. *Proexochokefalos* possessed large, slightly mediolaterally compressed teeth with pointed apices throughout the entirety of the jaws, differing from *Neosteneosaurus*. In addition, its most characteristic feature is the enlarged basioccipital tuberosities, which are the insertion points for the *m. rectus capitis ventralis* and *m. longissimus capitis profundus*, influencing head and neck flexion (Snively & Russell, 2007). In addition, two partial '*Steneosaurus*' skulls has been reported from the Callovian of India (Phansalkar et al., 1994); however, these specimens are currently unavailable, and it is unclear where they are housed. There were some major characteristic features appearing in the Callovian, distinguishing most members of Machimosaurinae from the rest of the teleosauroids; one example is the loss of antorbital fenestrae in *Proexochokefalos*, *Neosteneosaurus* and *Lemmysuchus*.

Another gap in teleosauroid evolution is prevalent in the Oxfordian (~159.4 to 154.1 mya), with fragmentary material attributed to '*Steneosaurus*' cf. *obtusidens* from Britain (Foffa et al., 2015) and *Machimosaurus* sp. from France and Portugal (Sauvage, 1897-98; Hua, 1996; Lepage et al., 2008; Young et al., 2014a). As with the Aalenian-Bajocian gap, this is puzzling, and may be due to factors such as environmental changes, poor preservation or simply not finding the fossils. However, one important taxon that is thought to be from the lower Oxfordian (Cuvier, 1808, 1812, 1824; Geoffroy Saint-Hilaire, 1825) is *Steneosaurus rostromajor*, represented by a poorly preserved partial rostrum. Unfortunately, the specimen (MNHN.RJN 134c-d) does not display any characteristic features, so it is difficult to interpret its ecology (e.g. feeding or niche) (see Chapter VI for more information). During the Kimmeridgian (~154.1 to 150.7 mya), teleosauroids as a group were becoming less common in coastal/brackish marine settings, particularly so in the Kimmeridge Clay Formation of the UK (Seeley, 1869; Young & Steel, 2014; Foffa et al., 2018b). However, machimosaurins remained relatively abundant during this time and flourished in high energy and open-ocean settings (Hua, 1999; Young et al., 2014a; Johnson et al., 2017). They were represented by three distinct species: *Machimosaurus buffetauti*, *Machimosaurus mosae* and *Machimosaurus hugii*. *Machimosaurus hugii* in particular was well adapted for living in an open sea habitat, due to enlarged

paraoccipital processes (an attachment surface for well-developed cervicocranial muscles for diving), zygapophyseal articulations in the vertebrae (allowing for strong lateral undulations of the tail) and reduced ornamentation (less vascularization) (Krebs, 1967, 1968; Young et al., 2014a). Hua (1999) suggested that *Mac*. *mosae* was adapted for higher energy environments (similar to *Lemmysuchus*); this is supported by thick osteoderms, robust ribs and gastralia and three sacral vertebrae, which all would have helped *Mac*. *mosae* to stay in place in a particularly turbulent setting; in addition, highly ornamented skull bones and osteoderms suggest frequent basking behaviour (Young et al., 2014a). *Machimosaurus buffetauti* is postulated to be an intermediate between the two (Young et al., 2014a). While the preservation of skull and postcranial material are rather uncommon for these taxa, numerous isolated teeth have been found throughout Europe and Britain. The taxa *Proexochokefalos* cf. *bouchardi* (a taxon similar in form to *Proexochokefalos heberti*) is rare, and mostly fragmentary material has been documented from France and Switzerland Lepage et al., 2008; Schaefer et al., 2018). In addition, the genus *Indosinosuchus*, hypothesized to have lived in freshwater rives (Martin et al., 2016, 2019), is represented by a handful of specimens and was moderately abundant throughout Thailand during the late Jurassic (the exact age of the corresponding sediments is currently unclear). As seen in other theorised freshwater teleosauroid taxa, *Indosinosuchus* possessed large, protruding orbits, elongate, pointed teeth and a weakly ornamented skull.

During the late Jurassic, a spectacular innovation occurred within teleosauroids, as indicated by the genera *Aeolodon*, *Bathysuchus* and *Sericodon*. These taxa independently adapted into a pelagic/deep water environment, highlighted by a suite of features: inconspicuous dermatocranial ornamentation; extreme reduction in osteoderm size, ornamentation and thickness; and a significantly shorter forelimb than hindlimb. Foffa et al. (2019) compared the morphologies of *Bathysuchus* and *Aeolodon* (both situated within Aeolodontini), noticing that features of the osteoderms and cranial ornamentation were similar. Shifting from a highly ornamented to poor/absent ornamentated osteoderms is indicative of a transition from amphibious to pelagic (Clarac et al., 2017). Foffa et al (2019) also noted that

highly ornamented bone allows for high vascularization, increasing basking efficiency, and highlighted the shift from the more heavily ornamented bone in the closely related *Mycterosuchus* to the weak ornamentation in *Bathysuchus* and *Aeolodon* (similar reduction of ornamentation is also observed in Metriorhynchidae: Fraas, 1902; Andrews, 1913; Herrera et al., 2017). Foffa et al. (2019) also performed two quantitative analyses using: (1) the humerus-femur (H:F) and (2) the tibia-femur (T:F) ratios; the authors found that the H:F of *Aeolodon* was very close to pelagic metriorhynchids, and the T:F was intermediate between teleosauroids and pelagic metriorhynchids. These measurements, along with the anatomical evidence and the knowledge that these specimens were recovered from deep-water sediments, hint that *Aeolodon* was likely living in a more pelagic habitat, exploiting a niche previously untouched by this group; Foffa et al. (2019) also hypothesized that *Bathysuchus* and *Sericodon* lived in a similar environment, given that they are anatomically similar to Aeolodon, are recovered from comparable deposits and are closely related phylogenetically. Unfortunately, *Aeolodon*, *Bathysuchus* and *Sericodon* are all relatively uncommon, with very few representatives for each genus (note that there are numerous teeth attributed to *Sericodon*, but in actuality, many of these have been misidentified and represent pterosaur teeth).

Teleosauroids nearly went extinct at the Jurassic-Cretaceous boundary, and there is only one known representative found in the Hauterivian-Barremian (~132.0 to 121.0 mya), the machimosaurin taxon *Machimosaurus rex*, represented by a fragmentary skull, vertebrae and isolated teeth (which possess the characteristic Machimosaurini anastomosing pattern). It is currently unclear why the majority of teleosauroids went extinct at this boundary. Some possible explanations include a gradual increase in temperature, shifting towards a more arid climate (evidence from spore-pollen data) (Hallam et al., 1991; Abbink et al., 2001; Michalík et al., 2011; Žák et al., 2011), gradual oceanographic changes (Žák et al., 2011; Price et al., 2016; Georgiev et al., 2017) and/or flood volcanism and rifting (Renne et al., 1992).

According to my phylogeny, it is evident that machimosaurids were much more common overall than teleosaurids throughout the entirety of teleosauroid evolutionary history. Teleosaurids appear to be much more specialized, in terms of anatomy and environment (for example, the freshwater taxa from Asia, or the pelagic teleosauroids from the UK and France). It is uncertain what exact features allowed machimosaurids to increase in abundance, as they are already extremely common in the Toarcian; a set of more generalized characteristics (e.g. dorsally directed nares) could have contributed to this widespread colonialization. The phylogeny also hints that there were three 'phases' within machimosaurids: a primitive phase (e.g. *Macrospondylus*), an intermediate phase (e.g. *Neosteneosaurus*, *Proexochokefalos*) and a derived phase (machimosaurins). However, in teleosaurids, there appeared to be no linear form of evolution. Machimosaurids also evolved large body sizes early in their evolution, with specimens of *Macrospondylus* reaching nearly 5 m in total length (e.g. GPIT-RE-9247). From that point onward, they exhibit a wide range of body sizes, both smaller (e.g. *Charitomenosuchus*) and larger (e.g. *Lemmysuchus*, *Machimosaurus*) than 5 m. In contrast, teleosaurids did not reach that size until the middle Callovian (e.g. *Mycterosuchus* NHMUK PV R 2617 is over 4.5 m in total length).

ECOMORPHOTYPIC DIVERSITY

The current phylogeny also highlights certain ecomorphological aspects of teleosauroids that have as of yet been unexplored (briefly touched upon in Chapter III). Their ecological structuring has been briefly examined by Hua (1997), Hua & Buffetaut (1997) and Foffa et al. (2018a), but was never discussed or published in great detail. Massare (1987) and recently Foffa et al. (2018a) characterized a variety of fossil marine reptiles based on the appearance and features of the teeth, separating various taxa into distinct 'guilds.' In Foffa et al. (2018a), seven teleosauroid taxa were included: *Machimosaurus* and *Lemmysuchus* were placed into the crunch guild, specialized for handling hard prey (e.g. turtles); the remaining taxa

(*Mycterosuchus*, *Charitomenosuchus*, *Neosteneosaurus* and *Proexochokefalos*) belonged to the pierce guild, preferring softer prey such as smaller fishes and squid. Currently, there are no known teleosauroid specimens confidently known preserve gut content (although this is a possibility for two housed at the SMNS, both unnumbered); however, more work needs to be undertaken on these specimens to confirm this.

While the feeding specializations for teleosauroids as a whole are currently under work (Johnson et al., in prep), there are a number of ecomorphotypes associated with certain taxa, based on osteological features. In zoological terms, an ecomorphotype is defined as morphological changes in a taxon or population that are the result of or related to specific ecological conditions. Throughout teleosauroid history, there are four key points during the Jurassic (Toarcian, Bathonian, Callovian and Kimmeridgian) in which there appears to be a specific pattern of certain ecomorphotypes appearing (Table 1; Fig. 2). These types are indicative due to the shape of the skull (longirostrine or mesorostrine), dentition and additional osteological characters that relate to the environment (e.g. length of the limbs, placement of the orbits, etc.). Teleosauroid skulls are generally split into two different 'morphs': longirostrine and mesorostrine, which relate to the length of the rostrum. Longirostry is defined as based on the preorbital length being 70% or more of the basicranial length and mesorostry is the preorbital length being 55-70% of the basicranial length (based on Andrade et al., 2011; see Chapter IV). This rostral classification is in turn is affiliated with features of the teeth, which include overall size and shape of the tooth, shape of apices, presence or absence of carinae and ornamentation.

Table 1. List of ecomorphotypes within teleosauroids in four main periods: the Toarcian, Bathonian, Callovian and Kimmeridgian. Note that '*S.*' *rostromajor* (Oxfordian), *Indosinosuchus* (Late Jurassic) and *Mac. rex* (Hauterivian-Barremian) are not included.

TAXA	PERIOD	ECOMORPH	CHARACTERISTIC FEATURES
Plagiophthalmosuchus gracilirostris	Toarcian	Longirostrine, specialist	Lateral orbits; elongated snout; slender pointed teeth
Macrospondylus bollensis	Toarcian	Longirostrine, generalist	Dorsal orbits; dorsal nares; 'generalized body plan

Platysuchus multiscrobiculatus	Toarcian	Longirostrine, semi-terrestrial	Dorsal orbits; anterior nares; heavy, integrated dorsal shield
Mystriosaurus laurillardi, Chinese teleosauroid	Toarcian	Mesorostrine, generalist	Dorsal orbits; anterior nares; shorter rostrum
Seldsienean megistorhynchus	Bathonian	Longirostrine, generalist	Dorsal orbits and nares; slender, elongated jaws
Deslongchampsina larteti	Bathonian	Mesorostrine, generalist	Dorsal orbits and nares; robust pointed teeth
Teleosaurus cadomensis	Bathonian	Longirostrine, semi-terrestrial	Dorsal orbits; 'spindly' teeth; heavy, integrated dorsal shield
Yvridiosuchus boutilieri	Bathonian	Mesorostrine, durophagous	Enlarged fenestrae; anastomosed blunt teeth
Andrianavoay baroni, Clovesuurdameredeor stephani	Bathonian	Unknown	N/A
Charitomenosuchus leedsi	Callovian	Longirostrine, generalist	Dorsal orbits and nares; gracile skeleton
Mycterosuchus nasutus	Callovian	Longirostrine, semi-terrestrial	Dorsal orbits and nares; protruding orbits; relatively elongated limbs; heavy osteoderms
Neosteneosaurus edwardsi, Proexochokefalos heberti	Callovian	Mesorostrine, generalist	Dorsal orbits and nares; robust, elongated skulls; large teeth
Lemmysuchus obtusidens	Callovian	Mesorostrine, durophagous	Enlarged fenestrae; anastomosed blunt teeth; reduced postcrania
Proexochokefalos cf. *bouchardi*	Kimmeridgian	Mesorostrine, generalist	Dorsal orbits and nares; robust elongated skull
Machimosaurus buffetauti, Machimosaurus mosae, Machimosaurus hugii	Kimmeridgian	Mesorostrine, durophagous	Enlarged fenestrae; anastomosed blunt teeth; reduced postcrania
Sericodon jugleri, Bathysuchus megarhinus, Aeolodon priscus	Kimmeridgian	Longirostrine, pelagic	Protruding orbits; weakly ornamented skull; reduced osteoderms; forelimb reduced

During the Toarcian, *Plagiophthalmosuchus* represented a longirostrine specialist (characterized by its laterally facing orbits, elongated snout and multiple thin, pointed, poorly ornamented teeth), and was likely a pure piscivore (Westphal, 1962). *Macrospondylus* represents a longirostrine

generalist and *Mystriosaurus* is a mesorostrine generalist (a massive, less elongated skull with smaller supratemporal fenestrae and more robust teeth). A heavily armoured, semi-terrestrial form is found in *Platysuchus*, indicated by the extensive and tightly packed rows of dorsal osteoderms. It is slightly difficult to select which ecomorphotype the Chinese teleosauroid (IVPP V 10098) fits into; no teeth are preserved. However, based on the definitions of longirostry and mesorostry, this taxon would have filled a mesorostrine role, possibly as generalist similar to *Mystriosaurus* (which is a logical assumption, given *Mystriosaurus* is a closely related taxon). By the Bathonian, laterally oriented orbits were lost in teleosauroids, so the niche held by *Plagiophthalmosuchus* disappeared. However, a new ecomorphotype evolved: the macrophagous/durophagous mesorostrine form, exhibited by *Yvridiosuchus*. A number of specific features, including enlarged supratemporal fenestrae, an extensive neurovascular system and blunt, conical teeth, characterized this ecomorphotype. The larger supratemporal fenestrae would have housed powerful adductor muscles for closing the jaw, and the robust, rounded teeth advantageous for capturing a wider or more generalised range of prey. There has also been some speculation that the evolution of machimosaurin features may have been linked to the evolution of hard shells in turtles; however, this possible correlation has yet to be confirmed and can be quite difficult to confirm, due to the overall extreme diversification and expansion of coastal marine ecosystems (M. Rabi, pers. comm.). In addition, modern alligators are also known to eat turtles without specialized crushing teeth (Rice, 2004).

In addition to the durophagous/macrophagous role in the Bathonian, *Seldsienean* filled the longirostrine generalist niche; *Deslongchampsina* took over the role of mesorostrine generalist; and *Teleosaurus* replaced *Platysuchus* as the longirostrine, semi-terrestrial form. The possible ecomorphotypes for both *Andrianavoay* and *Clovesuurdameredeor* are currently uncertain (although it is clear that they are non-machimosaurins); the majority of the rostral material, as well as teeth, are missing from *Clovesuurdameredeor*, making it difficult to infer skull and dental morphology, and the preserved rostral section (including the anterior and middle maxillae) of *Andrianavoay* has at least 20 maxillary alveoli preserved. In the mid-

Callovian, the ecomorphotypes within this ecological hierarchy did not change. *Lemmysuchus* represented a mesorostrine macrophagous/durophagous form; *Charitomenosuchus* became the longirostrine generalist; *Neosteneosaurus* and *Proexochokefalos* both filled the role of mesorostrine generalist; and *Mycterosuchus* represented the longirostrine, semi-terrestrial ecomorphotype. However, in the Kimmeridgian, there was another major shift in ecomorphotype variation. The mesorostrine macrophagous/durophagous form became the most dominant, with representatives in *Machimosaurus buffetauti*, *Machimosaurus mosae* and *Machimosaurus hugii*. The longirostrine generalist ecomorph disappeared, and the mesorostrine generalist form, represented by *Proexochokefalos* cf. *bouchardi*, was extremely rare. In addition, another new ecomorphotype evolved: a longirostrine, pelagic form, represented by a handful of genera (*Aeolodon*, *Bathysuchus* and *Sericodon*). During the Late Jurassic (the exact time is unknown), *Indosinosuchus* represented a mesorostrine form, possibly a mesorostrine generalist; in the Hauterivian-Barremian (early Cretaceous), *Machimosaurus rex* embodied the mesorostrine macrophagous/durophagous taxon, but all other ecomorphotypes had disappeared.

The position of these different ecomorphotypes is highlighted in the phylogeny. *Plagiophthalmosuchus*, the basal-most teleosauroid, is the only taxon demonstrative of the longirostrine specialist form. Mesorostrine generalists are represented in both teleosaurids and machimosaurids: the Chinese teleosauroid (IVPP V 10098), *Mystriosaurus* and *Indosinosuchus* (Teleosauridae); and *Deslongchampsina*, *Proexochokefalos*, *Proexochokefalos* cf. *bouchardi* and *Neosteneosaurus* (Machimosauridae). Interestingly, the remaining three ecomorphotypes are restricted to certain families. The longirostrine semi-terrestrial form is only found in Teleosauridae, represented by *Platysuchus*, *Teleosaurus* and *Mycterosuchus*. The longirostrine pelagic ecomorphotype is also restricted to Teleosauridae, as seen in *Aeolodon*, *Sericodon* and *Bathysuchus*. The longirostrine generalist (*Macrospondylus*, *Seldsienean*, *Charitomenosuchus*) and mesorostrine macrophagous/durophagous (*Yvridiosuchus*,

Lemmysuchus, *Machimosaurus*) ecomorphologies are only found in Machimosauridae.

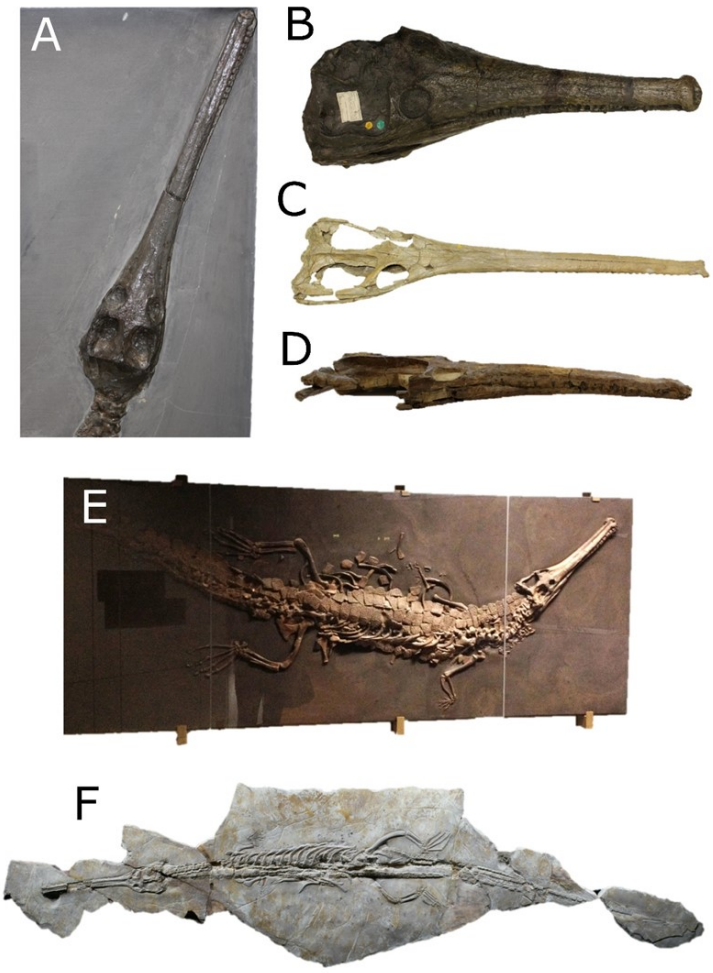


Figure 2. Six teleosauroid ecomorphotypes, based on osteology: (A) longirostrine specialist (*Plagiophthalmosuchus*: NHMUK PV OR 14792); (B) mesorostrine generalist (*Mystriosaurus*: NHMUK PV OR 14781); (C) longirostrine generalist (*Charitomenosuchus*: NHMUK PV R 3320); (D) durophage/macrophage (*Yvridiosuchus*: OUMNH J.29850); (E) semi-terrestrial morph (*Platysuchus*: SMNS 9930); and (F) pelagic morph (*Aeolodon*: MNHN.F.CNJ 78). Not to scale.

As seen in extant crocodilian species, larger individuals tend to be dominant, with larger species occupying prime territories (this is not an unbreakable rule, as interactions between *Crocodylus rhombifer* [Cuban crocodile] and *Crocodylus acutus* [American crocodile] in the Central Americas show). It is hypothetical that machimosaurids, being larger and more generalised, were able to assert dominance over smaller teleosaurids if

co-existing within the same ecosystem, and therefore occupied the better territories. This one possible selection pressure may have pushed teleosaurids into more specialised ecomorphotypical roles. This is similar to that seen in extant crocodilian subdivisions of West African ecosystems; the species *Crocodylus suchus* (West African crocodile), *Mecistops cataphractus* (West African slender-snouted crocodile) and *Osteolaemus tetraspis* (African dwarf crocodile) do not inhabit similar bodies of water (e.g. Kofron, 1992; Velo-Antón et al., 2014), and with decreasing size, all species live in smaller waterways, with *Osteolaemus* being capable of terrestrial foraging. This could be similar to the linear hierarchy seen in South American caimans: *Melanosuchus niger* (black caiman), *Paleosuchus palpebrosus* (Cuvier's dwarf caiman), *Caiman yacare* (Yacare caiman), Caiman crocodilus (spectacled caiman) and *Caiman latirostris* (broad-snouted caiman) (Ross, 1998; Busack & Pandya, 2001; Rebêlo & Lugli, 2001; Vasconcelos et al., 2006).

BIOGEOGRAPHICAL DISTRIBUTION

In terms of biogeography, teleosauroids achieved a near-global distribution (as mentioned previously). Numerous specimens have been found across both Gondwanan and Laurasian continents, having been reported from the UK and multiple localities in Europe, as well as Africa, Asia, India, Russia, Colombia and potentially North America (see Table 2; Fig. 3). Von Huene (1927) mentioned that teleosauroid material was present from north-western Argentina, but this specimen has been attributed to a metriorhynchid. However, despite this vast global dispersal, few studies have examined teleosauroid biogeography in detail. Buffetaut et al. (1981) suggested a Laurasian and Gondwanan faunal connection between Tethyan Europe and the southern area of Africa (e.g. Madagascar) via an epicontinental seaway during the early Jurassic. In the late Toarcian, the distribution of teleosauroids appeared parallel to the ammonite *Bouleiceras*, which occurs in Portugal (Mouterde, 1953), Spain (Geyer, 1956), Chile, Argentina (von Hilldebrandt, 1973), Madagascar, Algeria and Morocco (Buffetaut et al.,

1981), suggesting a marine connection from South America around Africa to the Tethyan area. Hua & Buffetaut (1997) hypothesized that teleosauroid distribution was similar to that of the saltwater crocodile (*Crocodylus porosus*) living amongst the Indian Ocean archipelagos.

Table 2. Comprehensive list of teleosauroid genera found in specific countries.

GENERA	COUNTRY	LOCALITY	MATERIAL FOUND
Plagiophthalmosuchus	Luxembourg; UK	Dudelange; Whitby	Partial skeleton; skull
Platysuchus	Germany; Luxembourg	Holzmaden; Foetz	Complete skeleton; rostrum
Mystriosaurus	Germany; UK	Altdorf; Whitby	Complete and partial skulls
Chinese teleosauroid	China	Daxian	Complete skull
Macrospondylus	Germany; ?France; Luxembourg; UK	Holzmaden; Bad Boll; Ohmden; Altdorf; Banz; Berg; Schlierbach; Ohmenhausen; ?Yonne; Sanem; Whitby; Sandsend; Greens-Norton	Multiple complete and partial specimens, as well as cranial and postcranial material
Deslongchampsina	France; UK	Calvados; Enslow Bridge	Near complete skulls
Clovesuurdameredeor	UK	Closworth	Partial skull and mandible
Yvridiosuchus	France; UK	Calvados; Enslow Bridge	Complete and partial skulls and mandibles
Teleosaurus	?China; France	?Sichuan province; Allemagne; Calvados	Partial cranium; osteoderms; postcranial material
Andrianavoay	Madagascar	Unknown	Partial skull and mandible, osteoderm fragment
Seldsienean	UK	Enslow Bridge; Kirtlington	Partial mandibles
Lemmysuchus	France; UK	Unknown; Peterborough	Complete skull and partial mandible; near complete skeleton and additional skull material
Charitomenosuchus	UK	Peterborough	Near compete skeleton as well as additional skull and postcranial material
Mycterosuchus	Germany; UK	Unknown; Peterborough	Complete skulls and postcranial material

Neosteneosaurus	UK	Peterborough	Near compete skeleton as well as additional skull and postcranial material
Proexochokefalos	France; Switzerland	Villers-sur-Mer; Villerville; Courtedoux-sur Combe Ronde	Complete and partial skulls; few postcranial material
Machimosaurus	Ethiopia; France; Germany; Portugal; Spain; Switzerland; Tunisia	Feyambiro; Ain; Ambleteuse; Cricqueboeuf; Issoncourt; Neuffen; Leiria; Lagares; Lourinhã; Malhão-Algarve; Peralta; Porto das Barcas; Zimbral; Asturias; Buñol; Solothurn; Touil el Mhahir	Skulls, mandibles, postcrania; numerous isolated teeth
Indosinosuchus	Thailand	Pho Noi	Multiple skulls and partial postcranial material
Sericodon	Germany; Switzerland	Hannover; Ahlem; Tönniesberg; Courtedoux-Bois de Sylleux; Courtedoux-sur Combe Ronde; Courtedoux-Tchâfouè; Courtedoux-Vâ Tche Tchâ	Numerous teeth; partial skull and postcranial material
Aeolodon	France; Germany	Canjuers; Daiting	Near complete skeletons
Bathysuchus	France; UK	Quercy; Kimmeridge	Nearly complete skull and partial mandible; rostral material
'*Steneosaurus*' sp.	Belgium; France; Germany; India; Poland; Russia; UK	Lorraine; Poitiers; Vaches Noires; Bartenbach; Bhuj; Czarnogłowy; Dagestan; Kirtlington; Whittlesea	Partial rostra and skulls; postcranial material; teeth
'*Teleosaurus*' sp.	China; India; UK	Beipei; Kota; Kirtlington; Slape Hill Quarry	Postcranial material; osteoderms
Machimosaurus sp.	France; Portugal; Spain; Switzerland; UK	Haudainville; Porto das Barcas; Peralta; Zimbral; Buñol; Moutier; Oker quarry; Solothurn; Lyme Regis; Dorset	Teeth

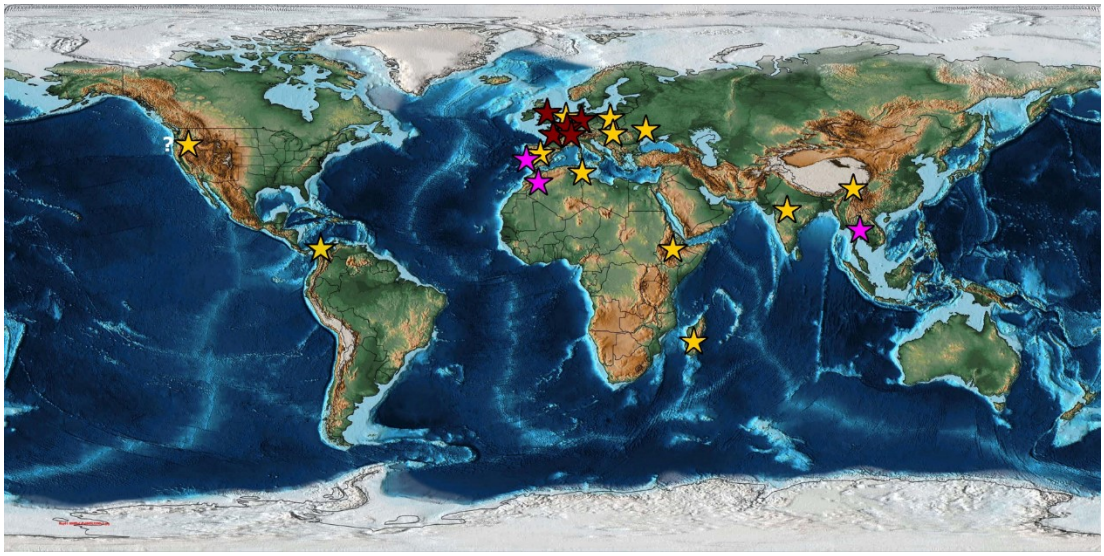


Figure 3. Present world map, indicating countries where teleosauroid material has been found (indicated by stars). A red colour specifies abundant material (>15 specimens), pink colour indicates decently represented material (10-15 specimens) and yellow colour shows rare material (<10 specimens). Note the specimen bias in western European countries, and that the **(?)** North American site is questionable. Map provided by PALEOMAP PaleoAtlas©.

During the late Toarcian (Fig. 4), teleosauroids were already biogeographically diverse. Diagnostic representatives of both Teleosauridae and Machimosauridae, as well as the basal teleosauroid *Plagiophthalmosuchus*, were found throughout Whitby Mudstone Formation in Britain (*Mystriosaurus*, *Macrospondylus*), the '*schistes bitumine*ux' in Luxembourg (*Macrospondylus*, *Platysuchus*), an unknown locality in France (*Macrospondylus*) and the Posidonia Shale Formation in Germany (*Platysuchus*, *Macrospondylus*, *Mystriosaurus*). In Asia, the Chinese teleosauroid and '*Teleosaurus*' were noted from the Ziliujing Formation of Beipei, Sichuan in China (Li, 1993; Li et al., 2011). There are also '*Steneosaurus*' sp. reported from Belgium ('*oolithe ferrugineuse*'), India (Kota Formation), Madagascar (Kandreho Formation) and possibly Portugal during this time (Owen, 1852; Buffetauti et al., 1981; Godefroit, 1994). These multiple occurrences in a variety of localities indicate that during the beginning of teleosauroid evolution, they were already radiating across the world, possibly following the coastline.

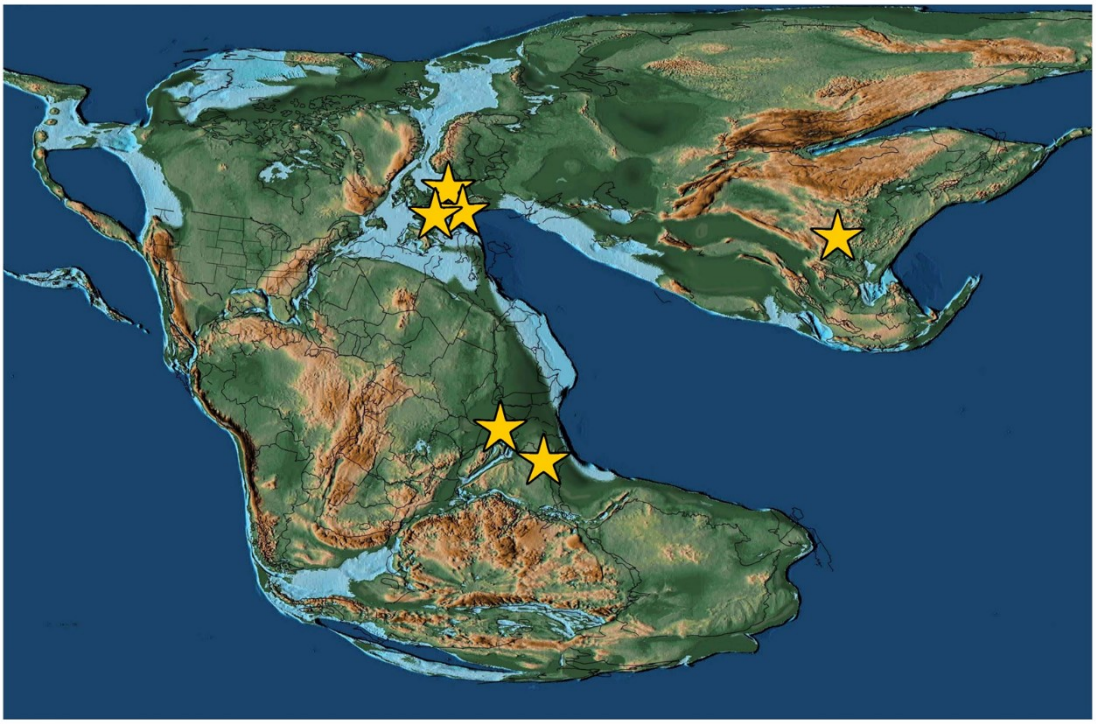


Figure 4. Map of the Toarcian (~189.6 to 180.1 mya), highlighting teleosauroid distribution (indicated by yellow stars). Note that, despite being early in their evolution, this clade had already dispersed south and east at great lengths, possibly by using the coasts. Map provided by PALEOMAP PaleoAtlas©.

During the Aalenian and Bajocian, there are very few teleosauroid occurrences, but there are a couple of important '*Steneosaurus*' sp. found from Slovakia (Pieniny Klippen Belt unit; Aalenian) and Dagestan Republic (Karakh Formation; Aalenian). During the Middle Jurassic (Late Aalenian to Early Bajocian), Buffetaut (1979) reported teleosauroid material from Oregon (USA); this material has since been attributed to a member of Metriorhynchoidea (Wilberg, 2015b). However, some non-documented, additional fragments from the same timeframe and locality are still labelled as 'Teleosauridae' (NMNH PAL 357211 to 357215). In the Bathonian, teleosauroids have been reported from multiple localities in France (*Yvridiosuchus*, *Teleosaurus*, *Seldsienean*, *Deslongchampsina*, '*Steneosaurus*'; Eudes-Deslongchamps, 1867-68; Johnson et al., 2019), Britain (*Clovesuurdameredeor*, *Yvridiosuchus*, *Teleosaurus*, *Seldsienean*, *Deslongchampsina;* Eudes-Deslongchamps, 1867-68; Johnson et al., 2019), Madagascar (*Andrianavoay*; Newton, 1893) and Morocco (Machimosaurini indeterminate).

There is a multitude of occurrences in the Callovian (Fig. 5A), namely situated in Britain (Oxford Clay Formation): taxa found in this area include *Mycterosuchus*, *Charitomenosuchus*, *Neosteneosaurus* and *Lemmysuchus*. Teleosauroids such as *Proexochokefalos* (Marnes de Dives Formation), *Lemmysuchus* (Quercy) and '*Steneosaurus*' sp. (unknown formation) are found in France, as well as '*Steneosaurus*' sp. (Chari Formation) in India. As with the Aalenian-Bajocian, there few teleosauroids reported from the Oxfordian. However, there are a couple of specimens reported from unique localities, such as *Machimosaurus nowackianus* from Harrar, Ethiopia (von Huene, 1938; Bardet & Hua; Young et al., 2014a), *Machimosaurus* sp. (*Perisphinctes cautisnigrae* ammonite zone), *L*. cf. *obtusidens* (Corallian Group; Foffa et al., 2015) from Britain and '*Steneosaurus*' *rostromajor* (possibly Marnes de Villiers Formation; Cuvier, 1812, 1824; Geoffroy Saint-Hilaire, 1825) from France. In the Kimmeridgian (5B), teleosauroids are found in several localities: *Bathysuchus* from the Kimmeridge Clay Formation (UK); *Mac*. *hugii*, *Sericodon* and '*Pr*.' cf. *bouchardi* from the Reuchenette Formation (Switzerland); *Mac*. *buffetauti* from the Lacunosamergel Formation (Germany); *Mac*. *hugii* from the Alcobaça and Lourinhã Formaions (Portugal), as well as the Lastres and Tereñes Formations (Spain) and 'Calcaires Coquilliers' (Cricqueboeuf, France); and '*Pr*.' cf. *bouchardi* from the '*Calcaire de Caen*' (France) (e.g. Lepage et al., 2008; Young et al., 2014a; Schafer et al., 2018; Foffa et al., 2019). In addition, *Machimosaurus* sp. is found in Germany (Langenberg Formation), the UK (Kimmeridge Clay Formation), Switzerland (Reuchenette and unknown Formations) and Portugal (Lourinhã Formation) (e.g. Young & Steel, 2014; Young et al., 2014a), and '*Steneosaurus*' sp. has been found from the Czarnogłowy quarry in Poland (Čerňanský et al., 2017). Tithonian localities are restricted to the Higueruelas Formation in Spain (*Mac*. *hugii*), the Mörnsheim Formation in Germany (*Aeolodon*) and the Canjuers lagerstätte and '*Marnes supérieures de la Meuse*' in France (*Aeolodon* and *Mac*. *mosae*, respectively). *Indosinosuchus* comes from the Late Jurassic Phu Kradung Formation of Phu Noi (north-eastern Thailand); dating this stratigraphic section is particularly tricky, as vertebrate fossils indicate a Late Jurassic age but palynomorphs suggest Early Cretaceous (Martin et al., 2019). A Late Jurassic, possibly Tithonian, age has been proposed (e.g. Liard and Martin,

2011; Cuny et al., 2014; Deesri et al., 2014; Liard et al., 2015), but this is currently unconfirmed. Only *Machimosaurus rex* (Fanti et al.) and Teleosauroidea indeterminate (Cortes et al., in press) have currently been reported from an Early Cretaceous Hauterivian-Barremian age (Tunisia and Colombia, respectively).

There are two geographically unique specimens that have been attributed to the genus '*Steneosaurus*': a partial skull from the Karakh Formation (Aalenian) of Dagestan, Russia (Efimov, 1988), and two skulls from the Chari Formation (Callovian) near Bhuj, India (Phansalkar et al., 1994). However, the Bhuj skull cannot be currently located and the Dagestan skull has been destroyed. This is unfortunate, not only in the loss of three valuable specimens, but also in the fact that their unique locations would provide invaluable information on which group of teleosaurids and/or steneosaurids were able to move into these remote areas. Efimov (1988) described the Dagestan skull as "*Вместе с тем в конфигурации краниальной пластины она обнаруживает сходство с верхнеюрскими видами стенеозавра, в частности с*S. larteti *и* S. edwardsi" ("At the same time, in the configuration of the cranial plate, it reveals similarities with the Upper Jurassic species [of] *Steneosaurus*, in particular, *S. larteti* and *S. edwardsi*") (Efimov, 1998: 52). This suggests that the Dagestan skull was possibly a type of machimosaurid; however, there are no actual photographs of the specimen, so this is difficult to confirm. In addition, Phansalkar et al. (1994) did not describe either of the Bhuj specimens, only noting their occurrence within the Chari Formation. There is one photograph of one skull, as well as two drawings, but they are quite poor, and no anatomical information can be gleaned from them. Nevertheless, these specimens exhibit the remarkable distributional success and adaptability that teleosauroids were able to achieve.

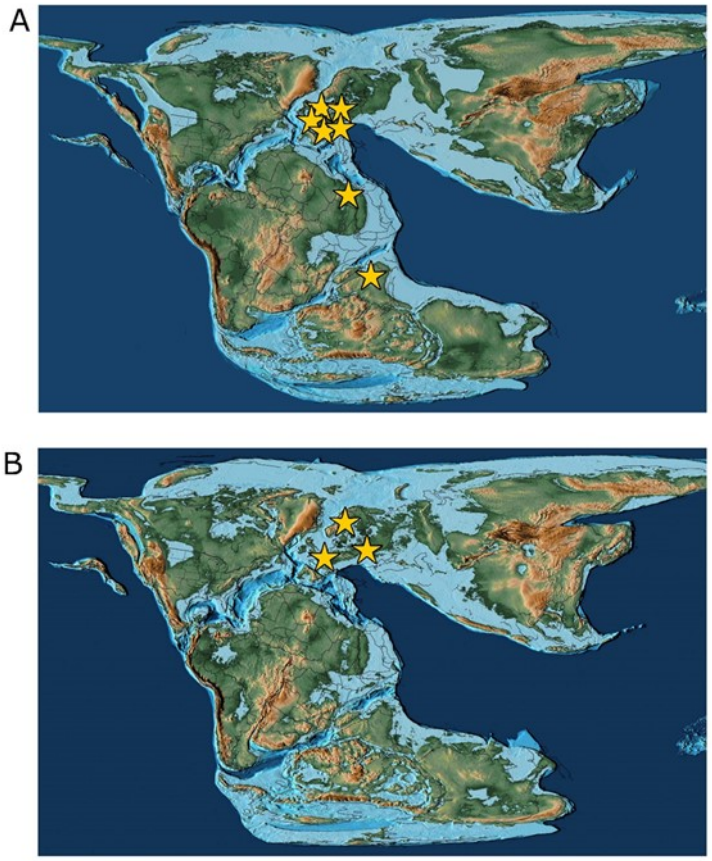


Figure 5. Maps of the (A) Callovian (~164.4-159.4 mya) and (B) Kimmeridgian (~154.1-150.7 mya), highlighting teleosauroid distribution (indicated by yellow stars). Note that this clade continued to portray occurrences along the Gondwanan coast in the Callovian, but gradually became more restricted to Europe in the Kimmeridgian. Maps provided by PALEOMAP PaleoAtlas©.

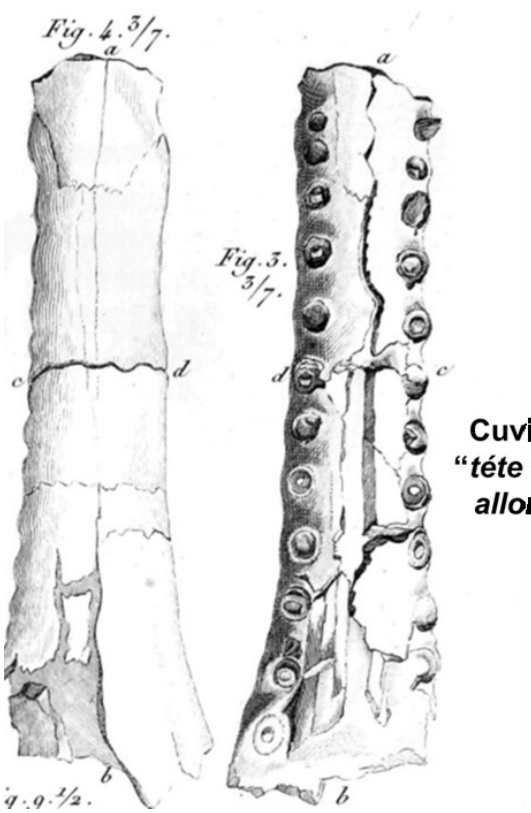
Similarly, as seen in their ecomorphological diversity, genera within both families are established themselves in different locations. Members of Teleosauridae are currently restricted to Laurasian continents, with *Teleosaurus*, *Aeolodon*, *Mystriosaurus* and *Bathysuchus* from the UK and Europe; *Mycterosuchus* from Britain and Germany; *Platysuchus* from Europe (Germany and Luxembourg); and *Indosinosuchus* and the Chinese teleosauroid from Asia. Members within Machimosauridae have an overall wider geographical span, ranging from the UK and Europe to northern Africa, Madagascar and possibly India, with machimosaurins in particular being prevalent in Africa.

CONCLUSIONS

Overall, teleosauroids show great diversity in species richness, ecomorphology and geographical distribution, debunking the myth that they were all relatively conservative in body plan and therefore living in similar habitats (Andrews, 1913). My updated phylogeny also provides six key insights to their evolutionary history: (1) at the start of their evolution in the Toarcian, teleosauroids were already extraordinarily diverse and abundant (how and why is unclear, in part due to the fact that the immediate ancestor of the group is unknown); (2) both teleosaurids and machimosaurids show a remarkable display of species diversity; (3) machimosaurids were substantially more common than teleosaurids throughout the entirety of the Jurassic, perhaps due to a more generalised body plan; (4) both families displayed certain unique feeding ecologies (e.g. a longirostrine pelagic morph in teleosaurids, and a macrophagous/durophagous morph in machimosaurids); (5) teleosaurids show a greater diversity in environmental niches than machimosaurids; and (6) machimosaurids were overall more globally widespread, whereas teleosaurids were more restricted to certain localities.

CHAPTER VI:

Emptying the Wastebasket: A Historical and Taxonomic Revision of the Jurassic Crocodylomorph *Steneosaurus*



Cuvier (1812: pl II): "*téte à museau plus allongé*" specimen

"A child of five could understand this. Send someone to fetch a child of five."

-Groucho Marx

PREFACE: This chapter is currently Johnson et al. (in review), and is a result of collaboration between myself and my supervisors Stephen L. Brusatte and Mark T. Young. The majority of this paper, including the descriptions, comparisons, figures and conclusions, was my original work. I visited accompanying museums to examine all the specimens included in the manuscript, took all the original photographs herein, and wrote and formatted the manuscript. Mark T. Young and Stephen L. Brusatte both provided thoughtful discussion, insight, and edited the manuscript.

INTRODUCTION

Teleosauroids (one of the two major clades within Thalattosuchia), were a near-global group of extinct crocodylomorphs that inhabited marine, brackish and freshwater ecosystems throughout the Jurassic (Andrews, 1913; Buffetaut, et al., 1981; Buffetaut, 1982; Hua, 1999; Foffa et al., 2015, 2019; Johnson et al., 2017, 2018, 2019; Martin et al., 2016, 2019) and Early Cretaceous (Fanti et al., 2016; Cortes et al., in press). They are often viewed as Jurassic analogues of extant gavials, as many species have an elongate and tubular snout, dorsally directed orbits and high tooth count, which suggests a primarily piscivorous diet (Andrews, 1909, 1913; Westphal, 1961, 1962; Buffetaut, 1982). Traditionally thought to be morphologically conservative, recent studies have shown teleosauroids to be a successful, diverse group in terms of anatomy, species richness and ecology (Buffetaut, 1982; Young et al., 2014a; Jouve et al., 2016; Johnson et al., 2017, 2019; Foffa et al., 2019; Martin et al., 2019; Sachs et al., 2019; Johnson, 2019).

Arguably, the most historically important and commonly discussed teleosauroid genus is *Steneosaurus*. Originally coined by Geoffroy Saint Hilaire in 1825, it has since been used as the generic distinction for a multitude of species throughout the 19th to 20th Centuries (e.g. Geoffroy Saint-Hilaire, 1825; J.A. Eudes-Deslongchamps, 1868b, 1868c; E. Eudes-Deslongchamps, 1867-69; Hulke, 1871; Sauvage, 1872; Blake, 1876; Morel

de Glasville, 1876; Hulke, 1877; Newton, 1893; Andrews, 1909, 1913; Phizackerley, 1951; Westphal, 1961; Buffetaut, 1980; Vignaud, 1998). However, it is unclear what *Steneosaurus* actually represents; it has long been considered a wastebasket taxon by researchers, one that nearly every known teleosauroid species has been placed into, and one of most notorious wastebaskets in archosaur systematics. In addition, the type specimen of *Steneosaurus*, *Steneosaurus rostromajor* (MNHN.RJN 134c-d), is often overlooked in the literature. These taxonomic complications undoubtedly play a significant part in the ongoing problems of larger teleosauroid taxonomic and phylogenetic studies, in which *Steneosaurus* has been considered paraphyletic (e.g. Mueller-Töwe, 2006; Jouve, 2009; Foffa et al., 2019; Johnson et al., 2019).

Herein we provide an in-depth historical overview of the genus *Steneosaurus* as well as a detailed re-description of the type specimen MNHN.RJN 134c-d. We then compare MNHN.RJN 134c-d with corresponding teleosauroid taxa, declare it a *nomen dubium*, and abolish the genus *Steneosaurus*.

HISTORICAL BACKGROUND

*1.1 The work of Georges Cuvier (1808, 1812 and 1824) and his "*tête à museau plus allongé et court*" fossils*

Georges Cuvier (1769-1832), a famed French zoologist and naturalist, initially described a longirostrine fossil 'crocodilian' snout from Honfleur in 1800 (Cuvier, 1800), adding more detailed information about the specimen in 1808 and 1812. This specimen was part of a large assortment of fossils from the Honfleur area, originally assembled by Father Bachelet (in actuality Father Bacheley; the name Cuvier mentioned was a typographical error [Brignon, 2016]). Bacheley's fossils were given to the Museum d'Histoire Naturelle (MNHN) in Paris on the orders of Count Beugnot, an advisor of the state (Cuvier, 1812). Cuvier's 'crocodilian species' consisted of a partial rostrum and orbital region of the skull. Oddly, Cuvier (1812) wrote that the

rostral piece (pl. II, fig. 3-5), was part of the collection of M. Bexon, a renowned and respected mineralogist, and that the skull portion (pl. II, fig 9) belonged to Father Bacheley. Why Cuvier (1808, 1812) believed that the snout and skull were from the same animal is unclear (Cuvier's original figures confirm it to be MNHN.RJN 134, with the snout eventually labelled MNHN.RJN 134c-d and skull MNHN.RJN 134a-b). Nevertheless, all fossils were collected from "*un bane de marne calcaire endurcie, d'un gris bleuàtre, qui devient presque noirâtre quand il est humide*" ("a bed of calcareous marl, a bluish grey which becomes almost black when [it is] wet") (Cuvier, 1808: 3) found along the Seine and present in many areas such as Caux, Touque, Dives and Vaches Noires in France. Cuvier (1808, 1812) briefly compared the rostrum and skull to that of the gavial, stating that they are similar in generic characters but differ in specific ones, most notably snout length and width as well as frontal configuration.

In his 1824 book, *Recherches sur les ossemens fossiles tome V*, Cuvier (1824) labelled the rostrum/skull specimen he had previously described as "*téte à museau plus allongé*" (head with elongated snout). It is slightly clearer in the text who collected certain fossils and how Cuvier eventually acquired them, and it is implied that this specimen was assembled together using many pieces. Three of these pieces (previously noted and figured in Cuvier [1808, 1812]) were amassed to form the partial skull of one 'species': two came from Father Besson (a priest who received the fossils from Father Bacheley) and one from Mr. Faujas, which had been initially given to him by Besson (Cuvier, 1824); thus it is unclear why Cuvier (1812) initially mentioned M. Brexon as the possessor of two pieces. Six additional pieces from three different collections were also collected and assembled: two had remained with Father Bacheley, two had passed into the collection of M. de Drée and two arrived from Geneva sent by the late M. de Jurine (it was not stated which pieces were with which person). Cuvier's (1824: 149) reasoning for combining these pieces together was that "*j'ai vu que ce museau s'adaptoit si bien à ce crâne, qu'il ne me reste aucun doute qu'il n'y ait appartenu*" ("I saw that this snout fitted so well to this skull, that I have no doubt that it belonged to it") and that they had been "*dispersés par l'incurie et*

le peu de connoissances de leur premier possesseur" ("dispersed by the carelessness and lack of knowledge of their first possessor").

As in 1812, Cuvier (1824) described several characters of the original assembled specimen, referring to it as "*téte à museau plus allongé*", in which it differed from the modern gavial. However, his 1824 description was noticeably more in-depth than in 1812, noting several characteristics:

1. The fossil specimen is overall more oblong than that of the gavial;
2. In the fossil specimen, the supratemporal fenestrae are more elongated and oval-shaped, with a narrow sagittal crest, as opposed to the gavial. In addition, "*l'arcade*" ["the arch"] (presumably meaning the anterior rim of the fenestrae) is not as straight as in the gavial;
3. The frontal, lachrymal and jugal are not concave and the orbits are not as indented, in contrast to the gavial;
4. The frontal is much larger in the fossil specimen;
5. The (posterior) nasals widen to accommodate the anterior tip of the frontal in the fossil specimen; and
6. The palatines are much more 'bulging' in the fossil specimen than the gavial.

Cuvier (1824: 151) also noted that an additional specimen resembling that of his "*téte à museau plus allongé*" was found in the Darmstadt cabinets by Mr. Bauder (when is not known) and illustrated by Mr. Schleyermacher (Cuvier, 1824: pl. VI, fig. 10-15). It is unknown if this specimen is still housed within the Darmstadt collections, or what its identification (specimen) number may be; however, fig. 14 in Cuvier (1824) appears to illustrate the rostrum of the *Mystriosaurus laurillardi* holotype HLMD V946-948 (see Sachs et al., 2019).

In his notes, Cuvier (1824) also described a new specimen and referred to it as "*téte à museau plus court*" (head with shortened snout) (pl. X, fig. 5-7). This specimen, consisting of two snout fragments, had been housed at the Academy of Geneva, and was initially drawn by Cuvier in 1811 and subsequently published in a life-size lithograph by M. de La Bêche (Cuvier, 1824). Cuvier (1824: 153) described this specimen as being different from

both the gavial and the "*téte à museau plus allongé*" fossil mainly due to its shorter and broader shape. In addition, he figured a second specimen from Honfleur (pl. VIII, fig. 6-7) that, based on its form, "*…est absolument la même que dans le museau de Genève, et je ne vois pas comment il s'adapteroit à ma première tête*" ("…is absolutely the same as in the muzzle of Geneva, and I do not see how it would adapt to my first [skull]") (his 'first skull' refers to the "*téte à museau plus allongé*" fossil). Despite describing and figuring both of these 'species' in relative detail, Cuvier (1812, 1824) did not assign them scientific names, continuing to refer to them as "*téte à museau plus allongé et court*" ("head[s] with elongated snout and shortened snout").

1.2 Geoffroy Saint-Hilaire (1825 and 1831) and the creation of the genus Steneosaurus

Étienne Geoffroy Saint-Hilaire (1772-1844), another well-known French naturalist, also contributed substantially to the study of fossil teleosauroids; most notably, he erected the genus *Steneosaurus*, differentiating it from the then-commonly-used *Teleosaurus* as well as modern crocodile genera. He introduced and conceptualized *Steneosaurus* in a series of papers in the early-mid 1800s.

In 1825, he classified both of Cuvier's 1824 "*tete a museu plus of allongé et court*" specimens. Geoffroy Saint-Hilaire (1825: 147) initially discussed the "*tete a museu plus of allongé*" fossil (which he prematurely called the species *rostromajor*, before actually assigning a genus and species to the specimen), stating "*Toutefois, l'un des reptiles des carrières d'Honfleur,* rostro- major*, doit aux travaux ardens et persévérans de M. Cuvier une restitution presque entière. Il manque peu de chose à son crâne; mais comme ce sont les hérisséaux et toutes les parties sous-orbitaires et sous-temporales, je ne puis aujourd'hui comprendre utilement ce précieux morceau dans les précédentes comparaisons*" ("However, one of the reptiles of the quarries of Honfleur, *rostro-major* owes to the ardent and persevering M. Cuvier an almost complete restitution. It is missing [some of] its skull; but as these are the [bristles] and all the suborbital and sub temporal parts, I do not today usefully understand this precious piece in previous comparisons.") Importantly, Geoffroy Saint-Hilaire (1825: 147) stated that *rostromajor* refers

to one of the fossil Honfleur 'crocodilians' described by Cuvier in 1824, specifically the one with "*longues mâchoires*" (longer jaws) (referring to the "*tete a museu plus allongé*" specimen). Geoffroy Saint-Hilaire believed that, after a thorough comparison of *S. rostromajor* with other crocodilian taxa had been completed, *S. rostromajor* would not belong within the genus *Teleosaurus* or modern *Crocodylus* (1825: 147) and lists certain aspects which he alleged differentiated the Honfleur specimen from both *Gavialis* and *Teleosaurus*:

1. Disproportionate eyes that are laterally placed;
2. "*L'arc, dont le jugal l'ai partie, est singulièrement descendu et rentrant*" ("The arch, [of which] the jugal part, is singularly descended and returning"; presumably referring to the slight concavity of the dorsal rim of the jugal) (Geoffroy Saint-Hilaire, 1825: 148);
3. Thinning of the temporal regions; and
4. Higher occipital 'wings.'

Geoffroy Saint-Hilaire (1825) also recognized that the elongation of the snout did not necessarily mean that one extant or extinct animal was related to another, but rather that this was a plastic condition that had evolved multiple times throughout the animal kingdom. He therefore omitted rostral characters in his comparisons of *S. rostromajor* with *Teleosaurus* and *Crocodylus*.

Based on the above characteristics, most notably those in the temporal region, Geoffroy Saint-Hilaire (1825) put forth the names *Steneosaurus rostro-major* (Cuvier's "*tete a museu plus allongé*" specimen) and *Steneosaurus rostro-minor* (Cuvier's "*tete a museu plus court*" specimen), with the genus *Steneosaurus* specifically referring to the 'gavials du Honfleur'. *Steneosaurus rostro-major* was the primary designated specimen (thus representing the type specimen of the genus, MNHN.RJN 134), while *Steneosaurus rostro-minor* was an accompanying specimen (Geoffroy Saint-Hilaire 1825: 149).

In 1831, Geoffroy Saint-Hilaire declared that an in-depth, comprehensive analysis between *Teleosaurus* and his new genus

Steneosaurus was needed to make the distinction between both genera "*parfaitement senti*" ("perfectly felt"). Geoffroy Saint-Hilaire (1831: 5) also wrote "*Réservant cette discussion pour la fin de mes recherches, je vais m'occuper aujourd'hui d'établir ce que sont véritablement les* Teleosaurus *et les* Steneosaurus*, c'est-à-dire leur assigner l'existence zoologique qui leur appartient*" ("Reserving this discussion for the end of my research, I am going [to be busy today] to establish what *Teleosaurus* and *Steneosaurus* really are, that is to say, to assign to them the zoological existence which belongs to them"). Geoffroy Saint-Hilaire (1831) then proceeds to define what is today interpreted as 'Teleosauridae' (although he did not assign a name to this group). Crucial features include: large 'vertical holes' (supratemporal fenestrae); vertically placed eyes; the parietal bone not intervening between the jugal and temporal; two arches ("*l'une supérieure jugo-temporale, l'autre inférieure maxillo-tympanique*": "one superior jugo-temporal, the other lower maxillofacial"); the development of the nasal (cranio-respiratory) canal and temporal region; and a 'beak-like' snout. At the end of this description, he writes "*Cette dernière combinaison remarquable dans les êtres téléosauriens devient des éléments caractéristiques pour une nouvelle famille; des éléments d'une puissance et d'une valeur à rendre en effet obligatoires les distinctions zoologiques de çette famille, c'est-à-dire l'érection des genres téléosaurus et sténéosaurus*" ("This last remarkable combination in teleosaurs becomes characteristic elements for a new family; elements of power and value to make compulsory the zoological distinctions of this family, that is to say the erection of the genera *Teleosaurus* and *Steneosaurus*") and "*L'indépendance de ces deux combinaisons anormales existe de fait: elle nous est révélée par l'organisation des sauriens fossiles du calcaire de Caen*" ("The independence of these two abnormal combinations exist in fact: it is revealed to us by the organization of fossil lizards [in] limestone [at] Caen") (Geoffroy Saint-Hilaire, 1831: 37-38). As mentioned previously, it is unclear at which taxonomic level Geoffroy Saint-Hilaire is referring to; just before writing this description, he refers to "*un cachet crocodilien*" ("a crocodilian stamp"), suggesting that he is describing the main features of teleosauroids (although this is never explicitly stated; however, perhaps his declaration to establish what *Teleosaurus* and *Steneosaurus* really were pertained to the both of them as a group, not individually). As with

his 1825 work, Geoffroy Saint-Hilaire (1831: 37) considered "*la région supérieure et vers la fin de l'arrière-crâne; et d'autre part le museau*" ("the upper region and towards the end of the back of the skull; and [on the other hand] the snout") to be the most important features when distinguishing teleosauroid fossil species, along with "*le canal nasal et le palais*" ("the nasal canal and the palate").

When defending the creation of the genus *Steneosaurus*, Geoffroy Saint-Hilaire (1831: 40) stated that "*… ce genre est exactement intermédiaire entre nos teleosaurus et le démembrement du grand genre Crocodile…*" ("…this kind is exactly intermediary between *Teleosaurus* and the [dismemberment] of the big genus Crocodile…"). Geoffroy Saint-Hilaire (1831: 41) also briefly noted his reason for the creation of the genus, in that "*Le nouveau genre sténéosaurus est en outre justifié par l'existence de plusieurs espèces: à Caen, j'en connais deux bien distinctes; à Honfleur, une troisième. Le crocodile fossile du cabinet de Genève est encore une autre espèce se rapportant aussi au genre sténéosaurus*" ("The new genus *Steneosaurus* is further justified by the existence of several species: in Caen, I know two quite distinct; in Honfleur, a third. The fossil crocodile of the Geneva cabinet is yet another species pertaining [also] to the genus *Steneosaurus*"). One major feature Geoffroy Saint-Hilaire (1831: 52) described as differentiating *Steneosaurus* and *Teleosaurus* was "*l'extrême différence de leur museau*" ("extreme difference of their muzzle") in that "*…les sténéosaures répètent assez bien l'arrangement que montrent à cet égard les gavials. Les narines y sont ouvertes supérieurement, et les intermaxillaires qui se développent autour, chacun en demi-cercle, leur fournissent un bord évasé, mais sans relief sensible. Les narines des téléosaures sont au contraire tout à fait antérieures et terminals…*" ("…the stenosaurs repeat quite well the arrangement that shows in [this respect] the gavials. The nostrils are open superiorly, and the intermaxillaries which develop round each, in a semicircle, give them a flared edge, but without any appreciable relief. The nostrils of the telosaurs are on the contrary quite anterior and terminal…"). Another feature used to distinguish between the two genera was dentition: the teeth of *Teleosaurus* were "*grêles et déjetées latéralement*" ("thin and laterally spindly") whereas in *Steneosaurus* "*les*

dents diffèrent peu de celles des gavials" ("the teeth differ little from [those of] gavials") (Geoffroy Saint-Hilaire, 1831: 52).

1.3 Realities of Cuvier and Geoffroy Saint-Hilaire's specimens

As mentioned previously, in Cuvier (1808, 1812, 1824), the original "*tete a museu plus allongé*" specimen (labelled *S. rostromajor* by Geoffroy Saint-Hilaire in 1825) was composed of three main parts: a two-part rostrum (MNHN.RJN 134c-d) and an orbital region (MNHN.RJN 134a). However, while both Cuvier (1808, 1812, 1824) and Geoffroy Saint-Hilaire (1825, 1831) thought all pieces originated from the same animal, in reality they did not; the rostral material (MNHN.RJN 134c-d) comes from a teleosauroid whereas the orbital section (MNHN.RJN 134a) represents the metriorhynchid *Metriorhynchus superciliosus* de Blainville, 1853 (Steel, 1973). The prefrontal of MNHN.RJN 134a has the characteristic enlarged, 'teardrop' shape of all metriorhynchids (e.g. Andrews, 1913; Herrera et al., 2013), which is an immediate diagnostic feature; in contrast, MNHN.RJN 134c-d displays the distinctive, posteriorly curving teleosauroid premaxilla-maxilla suture (both dorsal and ventral) as well as an overall elongated snout (particularly the maxilla bones), deeper maxillary reception pits and lack of a deep midline trench (=groove). Therefore, Cuvier's "*tete a museu plus allongé*" specimen is a chimera. In contrast, Cuvier's "*tete a museu plus court*" specimen (classified with the Geneva specimen as *S. rostrominor*, MNHN 8902, by Geoffroy Saint-Hilaire in 1825), which is represented by a complete mandible, is not a teleosauroid but rather represents the type specimen of a metriorhynchid and an objective synonym of *Metriorhynchus geoffroyii* (von Meyer, 1832) (Allain, 2001).

1.4 Post-Geoffroy Saint-Hilaire: von Meyer and colleagues (1830s and 1840s), J.A. and E. Eudes-Deslongchamps (1860s) and recent interpretations of 'Steneosaurus'

In 1832, von Meyer (1832) separated both of Cuvier's specimens on a generic level, assigning the name *Metriorhynchus geoffroyii* sp. nov. to *Steneosaurus rostrominor* and *Streptospondylus altdorfensis* sp. nov. to *Steneosaurus rostromajor*. Von Meyer (1832) included additional vertebrae

previously documented and described by Cuvier (1808, 1812) that were not associated with his "*tete a museu plus allongé*" specimen and that had been ignored by Geoffroy Saint-Hilaire (1825) when establishing '*S*.' *rostromajor* (Allain, 2001). The generic name *Streptospondylus* refers to the unusual structure of the vertebrae (von Meyer, 1832: 227); however, these vertebrae are from a theropod dinosaur and not a crocodylomorph (Allain, 2001). According to Article 67.2.1 of the International Commission on Zoological Nomenclature (ICZN), "A nominal species is only eligible to be fixed as the type species of a nominal genus or subgenus if it is an originally included nominal species [Art.67.2]." Therefore, the generic name *Streptospondylus* does not have any reference to '*S*.' *rostromajor*, as the vertebrae on which this name was based were originally not included with the type *S*. *rostromajor* skull material.

Bronn (1835-37) initially established the genus *Leptocranius* for Cuvier's "*tete a museu plus allongé*" (*S*. *rostromajor*) specimen, and referenced Cuvier's 1824 figure of the specimen (therefore, the genus *Leptocranius* is an objective junior synonym of *Steneosaurus*). Bronn (1835-37) diagnosed *Leptocranius* based on the following characteristics:

1. A narrow, elongated skull that is higher than it is wide;
2. Approximately 36 to 40 conical teeth with well separated alveoli;
3. Large, forward-directed orbits; and
4. Broad temporal (frontal) pits.

Because Bronn (1835-37) included features of the orbits and posterior skull in his description, it is likely that he considered all of the associated fossil material (both MNHN.RJN a-b metriorhynchid, and MNHN.RJN 134c-d teleosauroid) assembled by Cuvier to be from an individual animal. Fitzinger (1843) included *Leptocranius* in his teleosauroid classification, and Geinitz (1846) briefly described the *Leptocranius* type specimen, affirming that it was indeed originally Geoffroy Saint-Hilaire's (1825) *S*. *rostromajor*. Giebel (1847), also confirming that Bronn's new genus was based off Cuvier's first 'gavial du Honfleur', stated that Bronn (1835-37) separated *Leptocranius* from Geoffrey Saint-Hilaire's *Steneosaurus* and von Meyer's *Streptospondylus* "…*weil beide die converconcaven Wirbelkörper des*

Metriorhynchus ihren Gattungen zugeeignet und dieſem biconcave Wirbel zugeſchrieben haben" ("…as both have assigned their [hourglass] vertebrae of *Metriorhynchus* to their genera and to this biconcave vertebrae"), and wrote a brief description of *Leptocranius* that is nearly identical to that found in Bronn (1835-37) and Geinitz (1846). After Giebel's (1847) work, the genus *Leptocranius* is scarcely mentioned in the literature and it seems to have become considered a synonym of *Steneosaurus*.

Despite Geoffroy Saint-Hilaire's (1825, 1831) brief classification of both the genus *Steneosaurus* and the two *Steneosaurus* species, French father-and-son palaeontologists Jacques Amand and Eugène Eudes-Deslongchamps neglected the existence of both *S. rostromajor* and *S. rostrominor*, believing them to be invalid names. They were not alone in their opinion: the younger Eudes-Deslongchamps (1867-69: 109) mentioned that, in a letter to his father, de Blainville referred to *S. rostromajor* as a "*monstre anatomique*" ("anatomical monster"). The younger Eudes-Deslongchamps (1867-69: 242) cited the poor preservation of '*S.*' *rostromajor* (MNHN.RJN 134c-d) as one of the major reason why it was an insupportable taxon, describing the "*diverses brisures ou plutôt fendillements*" ("various breaks or [rather] cracks") that adorned the specimen "*profondément altéré les caractères*" ("profoundly altered the characters"). The Eudes-Deslongchamps briefly referred to *Leptocranius*, stating that Bronn (1837) "*le changea contre celui de* Leptocranius *et con serva celui de* Metriorhynchus" ("changed it [presumably the *S. rostromajor* type specimen] to that of *Leptocranius* and conserved [that] of *Metriorhynchus*). (Eudes-Deslongchamps, 1867-69: 116). However, they did not acknowledge nor describe it as a valid genus. Indeed, they appeared to criticise its existence, and scolded previous researchers for allowing problems associated with *S. rostromajor* to manifest, by not viewing the type specimen themselves: "*…leurs jugements sont-ils presque tous entachés d'erreurs et souvent d'erreurs gros sières*" ("…their judgments are almost all tainted with errors and often with gross errors") and "*…qui avaient prétendu juger Cuvier et Geoffroy Saint-Hilaire et s'étaient eux-mêmes trompés de la manière la plus manifeste*" ("…who had pretended to judge Cuvier and Geoffroy Saint-Hilaire, and had themselves deceived themselves in the most manifest manner") (Eudes-Deslongchamps, 1867-69: 107).

Due to this, both Eudes-Deslongchamps believed that the taxon to represent the genus *Steneosaurus* should be either '*Steneosaurus*' *megistorhynchus* Eudes-Deslongchamps, 1866a, or '*Steneosaurus*' *edwardsi* Eudes-Deslongchamps, 1868a. Eugène Eudes-Deslongchamps (1867-69: 220) described the situation as follows: "*E. Geoffroy-Saint-Hilaire donna le nom de Sténéasaure aux longs maxillaires à l'espèce qui nous occupe; mais il avait également en vue une autre espèce qu'il croyait être la même que celle-ci, c'est-à-dire le Gavial à museau allongé d'Honfieur que nous décrivons plus loin sous le nom de* Steneosaurus Edwardsi*; toutefois, comme E. Geoffroy-Saint Hilaire applique surtout ce terme de Sténéosaure au croco dile aux longs maxillaires de Quilly, nous conservons le nom de Sténéosaure aux longs maxillaires celui que nous décrivonseu ce montent. Plusieurs auteurs ont diversement traduit ce nom de Sténéosaure aux longs maxillaires: les uns ont mis rostro-major, d'autres longirostris. Le nom de* megistorhynchus *a sur ces divers noms l'avantage d'exprimer parfaitement le caractère de longueur démesurée du museau, et en second lieu d'avoir été choisi par E. Geoffroy-Saint Hilaire lui-même, puisqu'il désigne ainsi cette espèce dans la longue correspondance qu'il a eue avec mon père au sujet des Téléosauriens; c'est également sous ce nom que mon père le signale dans ses lettres à M. de Blainville sur les crocodiles vivants et fossiles. Pour ces diverses raisons, nous croyons qu'il est convenable de préférer le nom de* megistorhynchus" ("Geoffroy-Saint-Hilaire gave the name of '*Steneosaurus* [by] long maxillae' to the species which occupies us; but he also had in view another species which he believed to be the same as this one, that is to say, the Gharial with the extended muzzle of Honfleur which we describe below under the name of *Steneosaurus Edwardsi*; However, as E. Geoffroy-Saint Hilaire applies the term "*Steneosaurus*" to the crocodile in the long maxillae of Quilly, we retain the name "*Steneosaurus*" with the long maxillary teeth that we describe. Several authors have variously translated the name of *Steneosaurus* to the long maxillaries: some have put *rostro-major*, others *longirostris*. The name of *megistorhynchus* has on these various names the advantage of perfectly expressing the character of excessive length of the muzzle, and secondly of having been chosen by E. Geoffroy-Saint Hilaire himself, since he thus designates this a species in the long correspondence he had with my father concerning the Teleosaurians; it

is also under this name that my father indicates it in his letters to M. de Blainville on living and fossil crocodiles. For these reasons, we believe that it is convenient to prefer the name of *megistorhynchus*").

However, other than the fact that '*S*.' *megistorhynchus* possessed a long rostrum and was a name chosen by Geoffroy Saint-Hilaire when corresponding with J.A. Eudes-Deslongchamps, E. Eudes-Deslongchamps (1867-69) did not give any anatomical reason as to why he and his father believed that '*S*.' *megistorhynchus* should represent the type specimen of this genus. Curiously, E. Eudes-Deslongchamps (1867-69: 242) then noted in his description of '*Steneosaurus*' *edwardsi* Eudes-Deslongchamps, 1868a, that it was "*d'une espèce qui était évidemment identique avec celle dont Cuvier avait connu le museau seulement et qu'il avait désigné sous le nom de gavial à museau allongé d'Honfleur*" ("a species which was obviously identical with that of which Cuvier had known the muzzle only and which he designated as the elongated muzzle gavial"). The younger Eudes-Deslongchamps then allegedly showed his father the illustrations he had made of the specimen, prompting J.A. Eudes-Deslongchamps to name the specimen '*S*.' *edwardsi* in honour of a famous scholar (possibly M. Milne-Edwards, but this is never explicitly stated) whose friendship he treasured (Eudes-Deslongchamps, 1867-69: 242-243). It is therefore uncertain which of these two taxa E. Eudes-Deslongchamps originally considered *S*. *rostromajor* to belong under, or if he considered either as a viable option; he refers to '*S*.' *edwardsi* as being the most viable candidate, as indicated in a short footnote (Eudes-Deslongchamps, 1867-69: 110), but then writes "*Steneosaurus aux longs maxillaires ou Megistorhynchus, que s'applique le nom de Steneosaurus*" ("*Steneosaurus* with long maxillaries, or *Megistorhynchus*, that the name of *Steneosaurus* is applied") (Eudes-Deslongchamps, 1867-69: 112).

Following the work of both Eudes-Deslongchamps, the MNHN specimen of '*S*.' *rostromajor* was seldom mentioned and never figured in the literature. Geoffroy Saint-Hilaire's (1825) *S*. *rostrominor*, despite being classified as *Metriorhynchus* by von Meyer (1832), continued to serve as the generic basis for many metriorhynchid specimens, including '*Steneosaurus*' *gracilis*, '*Steneosaurus*' *palpebrosus* and *Plesiosuchus manselii*. Richard

Owen (1804-1892) was one individual who continued to use the genus *Steneosaurus* in reference to metriorhynchids, and was heavily criticized for this (e.g. Woodward, 1885: 501). Allain (2001) mentioned both of Cuvier's 'gavials' in his re-description of *Streptospondylus altdorfensis* (a theropod dinosaur), and verifies that Geoffroy Saint-Hilaire (1825) united the two specimens under the genus *Steneosaurus* and that both names did not apply to additional vertebrae that were previously described by Cuvier (1812) and disregarded by Geoffroy Saint-Hilaire (1825). Brignon (2016) briefly mentioned Cuvier's 'gavials du Honfleur' when describing Father Bacheley's contributions to French palaeontology, confirming that Cuvier's "*tete a museu plus allongé*" specimen did indeed belong to the French priest's collection (however, it is uncertain when this specimen received its official museum label, MNHN.RJN 134c-d).

As opposed to the species *S. rostromajor*, the genus *Steneosaurus* was widely accepted and predominately used when naming new teleosauroid species (e.g. Morel de Glasville, 1876; Hulke, 1871, 1877; Newton, 1893; Andrews, 1909, 1913; Phizackerley, 1951). It encompassed nearly all teleosauroid species at least once within their taxonomic history (excluding those within the genus *Machimosaurus*, which had been well established since von Meyer's 1837 and 1838 work). In addition, multiple recent phylogenetic studies on or including teleosauroids (e.g. Wilberg, 2015a, 2015b; Foffa et al., 2019; Johnson et al., 2019; Martin et al., 2019; Sachs et al., 2019; Johnson, 2019) have recovered various *Steneosaurus* species as either polyphyletic or paraphyletic, further adding to its taxonomic instability.

GEOLOGY

The exact age of *S. rostromajor* (MNHN.RJN 134c-d) is a subject of debate, as it is either Callovian or Oxfordian. It is confidently agreed upon, first noted by Bacheley (1778a, 1778b) and then by Cuvier (1808, 1812), that the fossil originated from Vaches Noires (Calvados, France). The Vaches Noires cliffs stretch approximately 5 km along the coast of France and are situated between the towns of Villers-sur-Mer (east) and Houlgate (west) (Buffetaut &

Tabouelle, in press). This site has yielded numerous vertebrate remains, including dinosaurs (von Meyer, 1832; Eudes-Deslongchamps, 1849; Bigot, 1898; von Huene, 1926b; Knoll et al., 1999), crocodylomorphs (Cuvier, 1824; Eudes-Deslongchamps, 1867-69; Wenz, 1970; Lepage et al., 2008; Brignon, 2016), marine reptiles (Bigot 1938; Blain et al., 2003; Bardet 2014) and fishes (Liston, 2008; Dutel et al., 2014; Liston & Gendry 2015; Brignon, 2016). There are two main formations exposed within the Vaches Noires cliffs: the Marnes de Dives (MD) Formation (upper Callovian) and the Marnes de Villiers (MV) Formation (lower Oxfordian) (Buffetaut, 1983; Brignon, 2016). Both formations consist of bioclastic mudstones (namely marl) and limestone; the MD Formation is approximately 8 to 10 m thick with lumachelle patches, and the MV Formation is roughly 25 m thick and interbedded with calcareous nodules (Dugé et al., 1998; Lebrun & Courville, 2013; Brignon, 2016). Both Bacheley (1778a, 1778b) and Cuvier (1808, 1812) have suggested that MNHN.RJN 134c-d comes from the MV Formation; if this is correct, then this fossil would be lower Oxfordian in age (which in itself is significant, as there are few teleosauroid fossils from this time period).

ABBREVIATIONS

Institutional: **CAMSM**, Sedgewick Museum, Cambridge, UK; **LPP** (**PALEVOPRIM-CVCU**), Institut de paléoprimatologie, paléontologie, humaine; évolution et paléoenvironnements Université de Poitiers, Poitiers, France; **MNHN**, Muséum national d'histoire naturelle, Paris, France; **NHMUK**, Natural History Museum, London, UK; **NOTNH**, Nottingham Natural History Museum, Nottingham, United Kingdom; **OUMNH**, Oxford University Museum of Natural History, Oxford, UK; **PRC**, Palaeontological Research and Education Centre, Maha Sarakham University, Thailand.

Anatomical: **M10**, maxillary alveolus 10; **mx**, maxilla; **?pal**, possible palatine; **pmx**, premaxilla.

SYSTEMATIC PALAEONTOLOGY

CROCODYLOMORPHA Hay, 1930 (sensu Nesbitt, 2011)

THALATTOSUCHIA Fraas, 1901 (sensu Young & Andrade, 2009)

TELEOSAUROIDEA Geoffroy Saint-Hilaire, 1831 (sensu Young & Andrade, 2009)

STENEOSAURUS Geoffroy Saint-Hilaire 1825

STENEOSAURUS ROSTROMAJOR (Geoffroy Saint-Hilaire, 1825)

TYPE SPECIES

(Fig. 1)

Etymology: named *rostro-major* ("major [elongated] rostrum") by Geoffroy Saint-Hilaire (1825), to emphasize the elongation of the maxillae. According to the ICZN Code, Article 32.5.2.3: "In a compound species-group name published as words united by an apostrophe or a hyphen, the words are to be united by removing the mark concerned." Therefore, *rostro-major* is recognized as *rostromajor*.

v 1800 'Crocodilian' snout; Cuvier, p. 159

v 1808 'Crocodilian' snout; Cuvier, p. 20-21, pl II, figs. 3-4

v 1812 'Crocodilian' snout; Cuvier, p. 20-21, pl II, figs. 3-4

v 1824 "*Téte à museau plus allongé*"; Cuvier, p. 148, pl. VII, figs. 3-4; pl. X, fig. 1

v 1825 *Steneosaurus rostromajor* nov. sp.; Geoffroy Saint-Hilaire, p. 146-147

v 1831 *Steneosaurus rostromajor*; Geoffroy Saint-Hilaire, p. 40

v 1832 *Streptospondylus altdorfensis*; von Meyer, p. 227

v 1835-37	*Leptocranius* nov. gen.; Bronn, p. 516
v 1841	*Steneosaurus rostromajor*; Owen, p. 88
v 1846	*Leptocranius*; Geinitz, p. 87
v 1847	*Leptocranius*; Giebel, p. 113-114

Holotype: MNHN.RJN 134c-d, a partial rostrum covered in ironstone sediment and oysters, and severely broken and dorsally displaced in the middle.

Holotype age: Callovian or Oxfordian, Middle or Late Jurassic (lower Oxfordian if from Marnes de Villiers Formation).

Holotype locality and stratigraphic horizon: Vaches Noires, Calvados, France. Suggested to be from the Marnes de Villiers Formation.

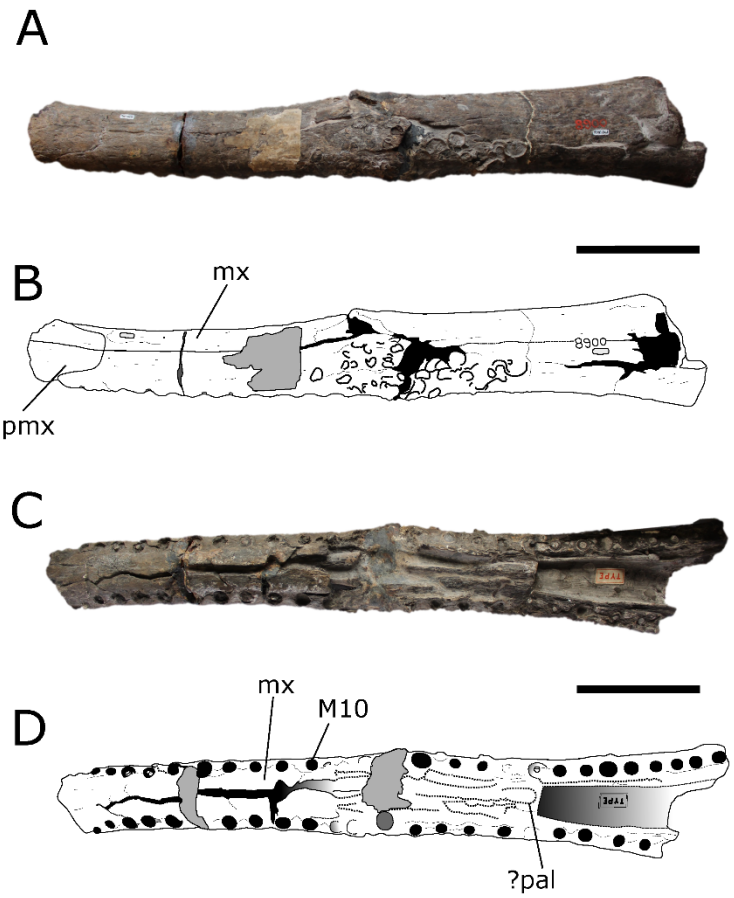


Figure 1. Photographs (A, C) and line drawings (B, D,) of *Steneosaurus rostromajor* (Geoffroy Saint-Hilaire, 1825), MNHN.RJN 134c-d, type specimen. Refer to the main text for the abbreviations list. Scale bars: 10 cm.

Description. The type specimen of *Steneosaurus*, *Steneosaurus rostromajor* (MNHN.RJN 134c-d) is represented by a partial rostrum that is preserved up until the 27th maxillary alveolar pair. The majority of the premaxillae are missing, so none of the premaxillary alveoli are preserved. At approximately the 12th maxillary alveolus, the remaining posterior portion of the specimen has been distorted and dorsally displaced (Fig. 1A-B); in dorsal view, there is a large posteriorly directed crack in this area, which is also covered with an array of fossilized oysters. In ventral view (Fig. 1C-D), there is a massive, anteroposteriorly directed crack running through the midline of the rostrum. At roughly the 19th alveolus, a missing section of the palatal surface continues to the end of the specimen.

Premaxillae. As mentioned previously, the majority of the premaxillae are not preserved, so neither the external nares nor any of the premaxillary alveoli can be described. However, the posterior-most portion of the paired premaxillae is robust and horizontally straight in lateral view; these bones would have surrounded the external nares, as in other teleosauroids (e.g. *Indosinosuchus potamosiamensis* Martin et al., 2019, PRC-11; '*Steneosaurus*' *leedsi* Andrews, 1909, NHMUK PV R 3806; '*Steneosaurus*' *edwardsi* NHMUK PV R 2865). In dorsal view, the premaxilla-maxilla suture is subcircular in shape and moderately interdigitating, most notably at the midline (Fig. 1A-B); in lateral view, it is slightly anteroposteriorly curved; and in ventral view, the posterior area is vertically directed, similar to that found in other teleosauroids (e.g. '*S.*' *leedsi* NHMUK PV R 3806; '*S.*' *edwardsi* NHMUK PV R 2865; NHMUK PV R 3701). The premaxillae are ornamented with numerous, irregular grooves with varying degrees of depth.

Maxillae. The paired maxillae (Fig. 1) are elongated, anteriorly separated from the premaxillae, transversely narrow and make up the majority of the rostrum. The dorsal surface of the maxillae are well ornamented with conspicuous, weakly-to-deeply excavated grooves. In lateral view, one line of small, sparsely spaced neurovascular foramina is present dorsally parallel to the maxillary tooth row. The reception pits are relatively deep in the anterior maxilla, but gradually become much shallower nearer to the posterior part of the rostrum. The anterior maxillae are unornamented in ventral view, and it is near impossible to observe any palatal features posterior to the 11th maxillary alveolus due to poor preservation. There are at least 27 maxillary alveoli per side, which are subcircular, large and well spaced (an extensive interalveolar region) throughout the entirety of the maxilla. Two anterior alveoli (Fig. 1C-D) have partially preserved teeth in the sockets.

Dentition: Only two partial teeth are preserved in situ in MNHN.RJN 134c-d (at the third and fourth left maxillary alveoli), both of which consist of the area near the base (they are both missing the apex and half of the tooth body). The teeth are slightly laterally compressed with numerous, well-developed and pronounced enamel ridges.

DISCUSSION

1.1 Comparisons with other teleosauroids

There has been much discussion about whether *Steneosaurus rostromajor* (MNHN.RJN 134c-d) should be classified as a distinct species or if it is referable to another teleosauroid taxon. One of E. Eudes-Deslongchamps' (1867-69) opinions was that *S. rostromajor* was similar to '*Steneosaurus*' *megistorhynchus*. However, the material with which both J.A and E. Eudes-Deslongchamps made this comparison has been lost; as there is no current available rostral material for '*S.*' *megistorhynchus*, it is difficult to assess this statement with confidence. However, '*S.*' *megistorhynchus* is Bathonian in age, whereas *S. rostromajor* (MNHN.RJN 134c-d) is suggested to be lower Oxfordian, as mentioned previously. Owing to this temporal gap of roughly 10 million years, it is highly unlikely that these represent the same species.

We have also listed several additional teleosauroid taxa (with substantial available skull material) that may hypothetically be equivalent to, and thus referable to, *S. rostromajor*. These are stated here and are used as follows (see Table 1): Hypothesis One: '*Steneosaurus*' *baroni*; Hypothesis Two: *Mycterosuchus nasutus*; Hypothesis Three: '*Steneosaurus*' *leedsi*; Hypothesis Four: *Lemmysuchus obtusidens*; Hypothesis Five: '*Steneosaurus*' *heberti*; and Hypothesis Six: '*Steneosaurus*' *edwardsi* (also considered by the Eudes-Deslongchamps).

Hypothesis One states that *S. rostromajor* (MNHN.RJN 134c d) could be similar to '*Steneosaurus*' *baroni* (NHMUK PV R 1999). However, '*S.*' *baroni* (NHMUK PV R 1999) is Bathonian in age, and is only recorded from a geographically distant locality (northwestern Madagascar); as with '*S.*' *megistorhynchus*, it is unlikely that *S. rostromajor* and '*S.*' *baroni* are the same species.

Figure 2. Comparative plate displaying the anterior rostrum in dorsal view of (A) *Steneosaurus rostromajor* (MNHN.RJN 134c-d); (B) '*Steneosaurus*' *baroni* (NHMUK PV R 1999); *Mycterosuchus nasutus* [(C) CAMSM J.1420; (D) NHMUK PV R 2617]; (E) '*Steneosaurus*' *leedsi* (NHMUK PV R 3320); (F) '*Steneosaurus*' *heberti* (MNHN.F 1890-13); (G) '*Steneosaurus*' *edwardsi* (NHMUK PV R 2865); and (H) *Lemmysuchus obtusidens* (LPP.M.21). Scale bars: 5 cm.

Hypothesis Two includes *Mycterosuchus nasutus* Andrews, 1913, as there was initial though by us that this taxon was a junior synonym of *S. rostromajor* due to both specimens having relatively similar ages. However, *S. rostromajor* (MNHN.RJN 134c-d) differs from *Myc. nasutus* (NHMUK PV R 2617) in the following:

1. The dorsal premaxillary-maxillary suture is triangular with no interdigitating in *Myc. nasutus* (NHMUK PV R 2617), whereas in *S. rostromajor* (MNHN.RJN 134c-d) the suture is relatively interdigitating near the midline and subcircular in shape (similar to '*S.*' *edwardsi* NHMUK PV 2865 and '*S.*' *heberti* MNHN.F 1890-13) (Fig. 2-3);
2. The premaxillae of *Myc. nasutus* (NHMUK PV R 2617; CAMSM J.1420) are strongly medially constricted at the premaxillae-maxillae suture, whereas there is little constriction in *S. rostromajor* (MNHN.RJN 134c-d);

3. *S. rostromajor* (MNHN.RJN 134c-d) is significantly less ornamented than *Myc. nasutus* specimens (CAMSM J.1420, NHMUK PV R 2617) (Fig. 2, 4); and
4. The maxillary reception pits are deep throughout the anterior and middle rostrum in *S. rostromajor* (MNHN.RJN 134c-d), whereas in *Myc. nasutus* (CAMSM J.1420, NHMUK PV R 2617) they are relatively shallow (Fig. 4).

Hypothesis Three, similar to Hypothesis Two, focuses on another taxon that is from approximately the same period: '*Steneosaurus' leedsi* (NHMUK PV R 3320, NHMUK PV R 3806). However, as with *Myc. nasutus* (NHMUK PV R 2617), there are some features that differentiate *S. rostromajor* (MNHN.RJN 134c-d) from '*S.*' *leedsi* (NHMUK PV R 3320; NHMUK PV R 3806):

1. The dorsal premaxillary-maxillary suture is anteroposteriorly elongated, subrectangular and extremely interdigitating in '*S.*' *leedsi* (NHMUK PV R3320; NHMUK PV R 3806), whereas in *S. rostromajor* (MNHN.RJN 134c-d) the suture is shorter, relatively interdigitating near the midline and subcircular in shape (Fig. 2-3);
2. There are differences in alveolar size throughout the rostrum of '*S.*' *leedsi* (NHMUK PV R 3320; NHMUK PV R 3806); in *S. rostromajor* (MNHN.RJN 134c-d) all preserved alveoli are relatively the same size;
3. The enamel ridges near the base of the tooth are small and faint in '*S.*' *leedsi* (NHMUK PV R 3320); in *S. rostromajor* they are well pronounced;
4. The rostrum is relatively more robust and ornamented in *S. rostromajor* (MNHN.RJN 134c-d) than in '*S.' leedsi* (NHMUK PV R 3320) (although this may be due to interspecific variation) (Fig. 5).

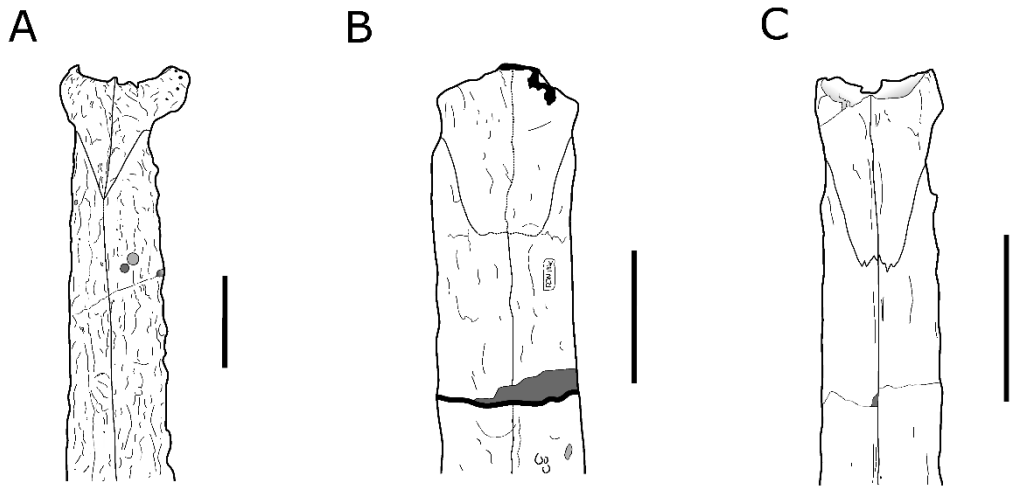


Figure 3. Line drawing highlighting the difference in premaxillae-maxillae suture, in dorsal view: (A) *Mycterosuchus nasutus* (NHMUK PV R 2617); (B) *Steneosaurus rostromajor* (MNHN.RJN 134c-d); and (C) '*Steneosaurus*' *leedsi* (NHMUK PV R 3320). Scale bar: 5 cm.

Hypothesis Four is that *S. rostromajor* could be positioned within the tribe Machimosaurini, or could possibly be referred to the Callovian taxon *Lemmysuchus obtusidens* (Andrews, 1909; Johnson et al., 2017) (which is one of the two teleosauroids situated at the base of Machimosaurini, the other being the Bathonian taxon *Yvridiosuchus boutilieri*). However, as with *Myc. nasutus* (NHMUK PV R 2617) and '*S.*' *leedsi* (NHMUK PV R 3806) in Hypotheses Two and Three, there are some major differences between *S. rostromajor* (MNHN.RJN 134c-d) and *L. obtusidens* (NHMUK PV R 3168). These include:

1. There is one line of smaller neurovascular foramina on the maxilla in *S. rostromajor* (MNHN.RJN 134c-d), whereas in *L. obtusidens* (NHMUK PV R 3168) there are two distinct lines of larger, subcircular foramina (Fig. 6);
2. The mid- and posterior-areas of the teeth are slightly compressed in *S. rostromajor* (MNHN.RJN 134c-d), whereas this compression is absent in *L. obtusidens* (NHMUK PV R 3168);
3. The reception pits (for the mandibular dentition) are deep throughout the entirety of the rostrum in *L. obtusidens* (NHMUK PV R 3168), whereas they are only deep anteriorly and mid-maxilla in *S. rostromajor* (MNHN.RJN 134c-d); and
4. The rostrum is noticeably less ornamented in *S. rostromajor* (MNHN.RJN 134c-d) than in both small and large *L. obtusidens* specimens (NHMUK

PV R 3168; NOTNH FS3361) (Fig. 5); in addition, *S. rostromajor* (MNHN.RJN 134c-d) is mainly ornamented with irregular grooves, whereas *L. obtusidens* (NHMUK PV R 3168) has both numerous irregular pits and grooves.

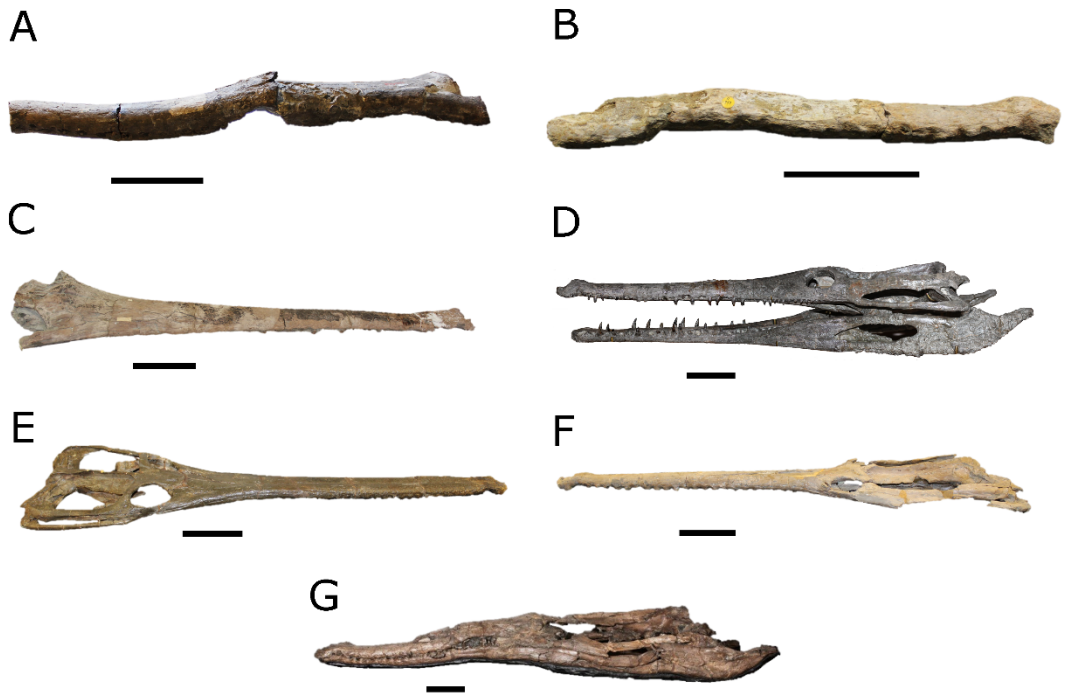


Figure 4. Comparative plate displaying the reception pits of (A) *Steneosaurus rostromajor* (MNHN.RJN 134c-d); (B) '*Steneosaurus*' *baroni* (NHMUK PV R 1999); (C) *Mycterosuchus nasutus* (CAMSM J.1420); (D) '*Steneosaurus*' *heberti* (MNHN.F 1890-13); (E) '*Steneosaurus*' *leedsi* (NHMUK PV R 3806); (F) '*Steneosaurus*' *edwardsi* (NHMUK PV R 2865); and (G) *Lemmysuchus obtusidens* (NHMUK PV R 3168). Scale bars: 10 cm (A-F) and 20 cm (G).

Hypothesis Five is that *S. rostromajor* (MNHN.RJN 134c-d) is a senior synonym to *'Steneosaurus' heberti* (MNHN.F 1890-13). These taxa are similar in that (1) the anterior reception pits are relatively deep and gradually disappear posteriorly; (2) '*S.*' *heberti* (MNHN.RJN 1890-13) has an ornamented rostrum comparable to that of *S. rostromajor* (MNHN.RJN 134c-d); and (3) the localities and ages of both specimens are comparable. However, *S. rostromajor* (MNHN.RJN 134c-d) is different from '*S.*' *heberti* (MNHN.F 1890-13) in three key characters:

1. The lateral constriction at the premaxillary-maxillary suture is relatively shallow in *S. rostromajor* (MNHN.RJN 134c-d), whereas in '*S.*' *heberti* (MNHN.F 1890-13) the suture is noticeably constricted (Fig. 5);

2. In lateral view, the premaxillae of *S. rostromajor* (MNHN.RJN 134c-d) are horizontally straight; in '*S.*' *heberti* (MNHN.F 1890-13), the premaxillae are noticeably convex (it is important to note that neither specimen is dorsoventrally crushed) (Fig. 4); and
3. The enamel ridges (situated at the base of the teeth) in *S. rostromajor* (MNHN.RJN 134c-d) are significantly more pronounced than in '*S.*' *heberti* (MNHN.F 1890-13).

*1.2 Comparison with '*Steneosaurus*'* edwardsi *and the fate of the genus* Steneosaurus

Due to the particular blend of characters in *S. rostromajor* (MNHN.RJN 134c-d) (as stated in the description), it appears not to be synonymous with the aforementioned teleosauroid taxa (Table 1). Therefore, by the process of elimination, the most probable species (approximately the same age) that it could pertain to is '*S.*' *edwardsi* (MNHN.RJN 118; NHMUK PV R 2865; NHMUK PV R 3701). This is our Hypothesis Six. As mentioned before, this was a second species that Eudes-Deslongchamps (1867-69) considered identical to *S. rostromajor*. These two taxa share a combination of features including:

1. A subcircular, moderately interdigitating premaxilla-maxilla suture;
2. Maxillae ornamented with irregular grooves;
3. A shallower mediolateral compression of the posterior maxillae, as opposed to '*S.*' *heberti* (MNHN.F 1890-13);
4. Horizontally flat posterior premaxilla in lateral view;
5. Deep anterior and mid-maxillary reception pits that gradually become shallower towards the posterior maxilla;
6. Subcircular to circular alveoli that remain relatively the same size throughout the maxilla; and
7. Teeth with well pronounced enamel ridges at the base.

Figure 5. Comparative plate displaying the rostral ornamentation of (A) *Steneosaurus rostromajor* (MNHN.RJN 134c-d); (B) '*Steneosaurus*' *baroni* (NHMUK PV R 1999); (C) *Mycterosuchus nasutus* (NHMUK PV R 2617); (D); '*Steneosaurus*' *leedsi* (NHMUK PV R 3806); (E) '*Steneosaurus*' *heberti* (MNHN.F 1890-13); (F) '*Steneosaurus*' *edwardsi* (NHMUK PV R 2865); and (G) *Lemmysuchus obtusidens* (NHMUK PV R 3168). Scale bars: 10 cm.

Figure 6. Comparative plate displaying neurovascular foramina of (A) *Steneosaurus rostromajor* (MNHN.RJN 134c-d) and (B) *Lemmysuchus obtusidens* (LPP.M.21). Note that *S. rostromajor* only has one line of foramina whereas *Lemmysuchus* has two. Scale bars: 2 cm.

However, it is important to note that many of these characters may in fact be related to sexual dimorphism, ontogeny and intraspecific variation. In modern crocodylomorphs, many dimorphic and ontogenetic studies revolve around embryonic material and soft tissues (e.g. Larsson, 1998), which is unhelpful when examining fossil specimens. Typical juvenile osteological features include larger orbits and shorter snouts (Monteiro & Soares, 1997; Monteiro et al., 1997; Bustard & Maharana, 1982); however, teleosauroids have proportionally larger heads when compared to their total body length (Young et al., 2016) and some hypothesized adult specimens have proportionally larger orbits (e.g. *Teleosaurus* MNHN AC 8746; *Indosinosuchus* PRC-11) when compared with total skull length, so commonly used osteological and biometric ontogenetic explanations cannot be confidently applied to this group. Sexual dimorphism in modern crocodylians, while well understood in the genera *Alligator* (Frey, 1988) and *Gavialis* (Whitaker & Basu, 1982), usually consists of measuring total body length (Kramer & Medem, 1955; Dodson, 1975; Platt et al., 2009) or skull size (Hall & Portier, 1994; Zeigler et al., 2003) when using skeletal material. While few studies have briefly investigated teleosauroid body sizes (e.g. Young et al., 2016), examining the growth patterns and body size distribution across the entirety of the group has not as of yet been attempted. As such, both teleosauroid sexual dimorphism and ontogeny is poorly understood and little studied (only briefly attempted by Vignaud [1995] and Mueller-Töwe [2006]). There are numerous specimens of varying sizes in the taxa '*Steneosaurus*' *bollensis* von Jäeger, 1828, '*S*.' *edwardsi* and '*S*.' *leedsi*, so these types of analyses are possible in the future. Furthermore, there is only one specimen classified as *S*. *rostromajor* (MNHN.RJN 134c-d), so the sample size for this supposed taxon is extremely limited. Not only that, but there is no current assured way of knowing if this individual is a juvenile or adult, or male or female (based on maxillae measurements comparable to larger '*S*.' *leedsi* and '*S*.' *edwardsi* specimens, it is hypothesized that it is a sub-adult or adult).

In addition to the sexual dimorphism/ontogeny problem, one of the critical issues about MNHN.RJN 134c-d is that it is very poorly preserved. As mentioned previously, the Eudes-Deslongchamps (1867-69) considered this

to be one of the determining factors which caused them to undermine *S. rostromajor*. MNHN.RJN 134c-d is missing nearly all areas of the skull that display diagnostic characters in teleosauroids, such as the temporal region and premaxillae. The maxillary rostrum itself is relatively undiagnostic; in the majority of longirostrine teleosauroids, the rostrum itself often displays many phenotypically plastic features (e.g. relative elongation of the maxillae, irregular ornamentation, subcircular alveoli) which do little in distinguishing species or examining internal relationships between taxa. Moreover, the preserved material in MNHN.RJN 134c-d is fractured, broken and severely dorsally displaced, with certain sections covered in ironstone oysters, particularly in the posterior areas (see Fig. 1). These factors make it difficult to compare with other taxa; rather than comparing characters outright, comparison is by process of elimination (or rather, the question of 'what features does this specimen not have?'). This is a slightly inconvenient way of examining specimens, but due to such limited material, it was the only way to attempt comparing MNHN.RJN 134c-d with other teleosauroid taxa.

Table 1. Comparison of certain rostral characters as well as age/locality between *Steneosaurus rostromajor*, '*Steneosaurus*' *baroni*, *Mycterosuchus nasutus*, '*Steneosaurus*' *leedsi*, *Lemmysuchus obtusidens*, '*Steneosaurus*' *heberti* and '*Steneosaurus*' *edwardsi*. **HYP** refers to the authors' proposed hypotheses (see text).

TAXA	Premaxilla-maxillae suture	Maxilla: reception pits, ornamentation	Posterior premaxilla (in dorsal and lateral view)	Dentition: enamel ridges, tooth base	Age and locality
Steneosaurus rostromajor (MNHN.RJN 134c-d)	Subcircular, moderately interdigitating	Deep anterior reception pits, ridges/grooves	Weakly constricted, horizontally straight	Well pronounced, compressed	Oxfordian, France

HYP:1 '*Steneosaurus*' *baroni* (NHMUK PV 1999)	Subcircular, moderately interdigitating	Deep anterior reception pits, ridges/grooves	Moderately constricted, horizontally straight	Unknown	Bathonian, Madagascar
HYP 2: *Mycterosuchus nasutus* (NHMUK PV R 2617)	Triangular, no interdigitating	Shallow reception pits, extremely ornamented and rugose	Strongly constricted, horizontally straight	Present but faint, compressed	Callovian, UK
HYP: 3 'Steneosaurus' leedsi (NHMUK PV R 3320; NHMUK PV R 3806)	Triangular, extremely interdigitating	Shallow reception pits, ridges/grooves	Moderately constricted, horizontally straight	Present but faint, compressed	Callovian, UK
HYP: 4 *Lemmysuchus obtusidens* (NHMUK PV R 3168; LPP.M.21)	Subcircular, moderately interdigitating	Deep reception pits throughout, ridges/grooves/ pits	Moderately constricted, horizontally straight	Well pronounced, no compression	Callovian, UK and France
HYP: 5 '*Steneosaurus*' *heberti* (MNHN.F 1890-13)	Subcircular, moderately interdigitating	Deep anterior reception pits, ridges/grooves	Strongly constricted, horizontally concave	Present, but faint	Callovian, France

HYP: 6 *'Steneosaurus' edwardsi* (NHMUK PV R 3701; NHMUK PV R 2865)	Subcircular, moderately interdigitating	Deep anterior and middle reception pits, ridges/grooves/ pits	Moderately constricted, horizontally straight	Well pronounced	Callovian, UK

A third concern is that, in reality, the name *Steneosaurus* is extremely impractical. It was used for many metriorhynchid specimens (e.g. '*Steneosaurus*' *gracilis*; '*Steneosaurus*' *palpebrosus*; '*Steneosaurus*' *manselii*) during much of the 19th Century, largely in part due to Cuvier's metriorhynchid skull region (MNHN.RJN 134a-b) being attributed to the teleosauroid rostral section (MNHN.RJN 134c-d). Indeed, the concise, classical definition of '*Steneosaurus*' as we interpret it today was not given until the work of both Eudes-Deslongchamps (1868a; 1867-69), which labelled it as a 'longirostrine' teleosauroid. The Eudes-Deslongchamps (1867-69: 109) understood that Cuvier's assemblage of the teleosauroid rostral and metriorhynchid skull pieces caused great confusion and unavoidable mistakes within teleosauroid nomenclature. They also recognised that the rostrum (MNHN.RJN 134c-d) was "*à la vérité très-mal conserve*" ("in truth very badly preserved") and that it was difficult to base an entire genus off of it. Unfortunately, their solution was to create a new type specimen for their updated definition (either '*S.*' *megistorhynchus* or '*S.*' *edwardsi*, as discussed above), but the ICZN Code does not allow this; according to Article 61.1.3, type specimens are stable and cannot be modified. Therefore, the original '*Steneosaurus*' specimen (MNHN.RJN 134c-d) must remain as the type. After the Eudes-Deslongchamps, what was left was an undiagnostic, chimeric type specimen (MNHN.RJN 134), whose genus was redefined using a new type specimen that was not accepted by some researchers. In addition, since the Eudes-Deslongchamps, there has been no attempt to rectify this taxonomic nightmare; it is almost as if, due

largely in part to taxonomic confusion, the existence of *S. rostromajor* was allowed to fade into the background. Since the latter half of the 19th Century, '*Steneosaurus*' itself has been crudely regarded as a wastebasket taxon, which multiple phylogenetic studies have found to be either paraphyletic or polyphyletic (e.g. Mueller-Töwe, 2006; Foffa et al., 2019; Johnson et al., 2019) (Fig. 6). These problems alone are enough to warrant extreme scepticism on the validity of *Steneosaurus*.

Due to these three significant factors (uncertainty of variable characters, poor preservation and unreasonable name), we have concluded that *S. rostromajor*, and therefore '*Steneosaurus*' (MNHN.RJN 134c-d), cannot be confidently assigned to an existing teleosauroid species. When examining all available characters, the taxon with which it could potentially be synonymous with is '*S.*' *edwardsi*; however, due to 'weak' or variable characteristics, and with no autapomorphic '*S.*' *edwardsi* features preserved on MNHN.RJN 134c-d, it is premature to assume that they are the same. MNHN.RJN 134c-d itself is undiagnostic at the genus and species level; while it retains certain teleosauroid characteristics (e.g. elongated maxillae, a straightened premaxilla-maxilla suture in palatal view), it does not display any autapomorphic features of lower level groups. In addition, MNHN.RJN 134c-d was initially diagnosed based on significant orbital and temporal characteristics (from the metriorhynchid MNHN.RJN 134a-b) along with generic rostral ones; because the skull material is now known to be from a metriorhynchid, this 'hybrid type specimen' factor adds to the doubtful validity of *Steneosaurus*. According to Article 23.8 of the ICZN Code, "a species-group name established for an animal later found to be a hybrid [Art. 17] must not be used as the valid name for either of the parental species [even if it is older than all other available names for them]" (this also signifies that the species name *rostromajor* is itself invalid). As such, MNHN.RJN 134c-d serves as an undiagnostic specimen; we therefore consider MNHN.RJN 134c-d to be a *nomen dubium* and, as such, *Steneosaurus* is treated as an undiagnostic genus.

CONCLUSIONS

Steneosaurus is one of the most historically important yet highly controversial genera within Teleosauroidea, and within Crocodylomorpha generally. The type specimen (‘*S*.’ *rostromajor*: MNHN.RJN 134c-d) was initially described and figured by Cuvier in 1800, but was not scientifically named until 1825 by Geoffroy Saint-Hilaire. Due to its complicated and often confusing history, MNHN.RJN 134c-d has been poorly studied and often overlooked when referring to other *Steneosaurus* taxa. In addition, *Steneosaurus* is regularly found to be either paraphyletic or polyphyletic in thalattosuchian phylogenies. This is in part due to the uncertainty of what *Steneosaurus* actually pertains to; only recently has the validity of this genus been scrutinized.

In this paper, we re-described and revised the type material of *Steneosaurus* (*S. rostromajor*: MNHN.RJN 134c-d), a poorly preserved partial rostrum collected from the Vaches Noires cliff in France. We then compared MNHN.RJN 134c-d to other relevant teleosauroid species, including ‘*S*.’ *baroni*, ‘*S*.’ *heberti, Myc. nasutus*, *L. obtusidens*, ‘*S*.’ *leedsi* and ‘*S*.’ *edwardsi*. Through character comparison-and-elimination, the only taxon with which MHNH.RJN 134c-d could hypothetically be referred to is ‘*S*.’ *edwardsi*, but the two do not share any clear autapomorphic characters, or a unique combination of characters. Thus, due to lack of autapomorphic characters, poor preservation, uncertainty of teleosauroid ontogenetic or sexual dimorphic stages, and a generic concept that has changed through time, we agree with de Blainville that *S. rostromajor* is a “*monstre anatomique*” (“anatomical monster”). We find MNHN.RJN 134c-d to be undiagnostic, and allocate it as a *nomen dubium*, thus abolishing the genus *Steneosaurus*. This will necessitate a revised teleosauroid taxonomy, in which species previously referred to the genus *Steneosaurus* are given new generic names. This work will be published by us in a separate contribution, based on the comprehensive teleosauroid phylogenetic analysis in Johnson’s PhD thesis (2019).

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CHAPTER VII:

Conclusions and Future Work

"To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science."

- Albert Einstein

PREFACE: I was responsible for all the work carried out in this chapter, including the quantitative results, interpretations, figures and concluding remarks.

APPENDIX S3

S3.1: Ecomorphology_taxa.doc (modified from Excel file)

S3.2: Characters_ecomorph.doc

CONCLUSIONS

Thalattosuchians represent one of the most innovative examples of crocodylomorph evolution, and one group in particular, teleosauroids, were no exception. They are important in terms of palaeontological history (as they are one of the first crocodylomorph fossils to be described in the scientific literature in 1758) as well as morphology, ecology and global distribution (spanning from Madagascar to Southeast Asia during the beginning of their evolutionary history). However, despite the abundance of fossils and detailed documentation of their anatomy over the past decade, the phylogenetic relationships and evolutionary trends within Teleosauroidea are poorly understood, little studied and grossly neglected. This is likely due to the plethora of taxonomic issues, scarcity of specific taxa and lingering historical perspectives (e.g. all share a conservative postcranial skeleton with little variety) that plague this group. One major problem is the concept of '*Steneosaurus*', the most commonly used teleosauroid genus; there is little information on what it actually refers to, and the type specimen has rarely been figured or used in studies since the early 1800s. In addition, '*Steneosaurus*' is highly paraphyletic or polyphyletic in many recent thalattosuchian studies (e.g. Mueller-Töwe, 2006; Wilberg, 2015b, 2018; Ősi et al., 2018; Foffa et al., 2019; Johnson et al., 2019; Martin et al., 2019;

Sachs et al, 2019a, 2019b), and has only recently been called out as a wastebasket taxon. While there has been new work that begins to closely examine teleosauroid interrelationships (Foffa et al., 2019; Johnson et al., 2019; Sachs et al, 2019a, 2019b), there is still no current comprehensive phylogenetic analysis that examines the entirety of their evolution. The closest study that has ever attempted this was Mueller-Töwe's (2006) unpublished thesis; yet this work focused on select taxa (all Toarcian in age) and was littered with inconsistencies and incorrect anatomical information.

This thesis has set the task of providing an in-depth analysis into teleosauroid phylogenetics (with roughly 550 teleosauroid specimens examined, the largest dataset currently to date), as well as examining their morphology, ecology and evolutionary trends. Before diving into the tangles of teleosauroid phylogenetics, Chapter I explores their discovery origins and historical background, laying out a brief framework of various work that has been done from the later 18th Century to the present day. Chapter II then examines Toarcian teleosauroid diversity, focusing specifically on material collected from southern Luxembourg; three distinct taxa are identified ('*S*.' *gracilirostris*, '*S*.' *bollensis* and *Platysuchus*) as well as a possible fourth (as indicated by the presence of three premaxillary alveoli). In Chapter III, some of the taxonomic issues found within teleosauroids are explored, with two historically important taxa ('*S*.' *larteti* and '*S*.' *boutilieri*) being re-described and two new genera established, *Deslongchampsina* and *Yvridiosuchus* (with *Yvridiosuchus* representing the oldest substantial material of a machimosaurin yet found anywhere in the world). In addition, ecomorphotypes within the Bathonian of the UK are discussed, along with the mention that while teleosauroid diversity changes, the ecological structuring within the Bathonian-Callovian of the UK remains relatively the same.

Chapter IV focuses on key teleosauroid osteological characters, as well as the taxonomy and phylogenetic methods and results. This study incorporates the H+Y dataset first provided in Ristevski et al. (2018) that has undergone substantial changes since its original publication. Herein, 38 new characters and 19 additional teleosauroid taxa are added, in addition to the

substantial re-scoring of all remaining teleosauroid taxa (based on personal observation). All new characters included in this dissertation are described and illustrated, as are all teleosauroid taxa included in the study. The updated dataset was analysed using parsimony (unweighted and weighted) in TNT 1.5, as well as non-gamma, gamma and variable Bayesian analyses. The newly produced topology, based on the more resolved implied weighting analysis, agrees with recently published analyses (e.g. Foffa et al., 2019; Johnson et al., 2019) on four key features: (1) the monophyly of Teleosauroidea; (2) the recovery of *Plagiophthalmosuchus gracilirostris* as the basal-most teleosauroid;(3) the division of teleosauroids into two major subgroups; and (4) the inclusion of Machimosaurini in one of these major subgroups. Based on these new results, the families Teleosauridae and Machimosauridae, subfamilies Teleosaurinae, Machimosaurinae and 'Mystriosaurinae', and tribe Aeolodontini are all recognized, defined and described. In addition, two genera are resurrected (*Macrospondylus* and *Sericodon*), as well as seven new genera established (*Plagiophthalmosuchus*, *Clovesuurdameredeor*, *Seldsienean*, *Charitomenosuchus*, *Proexochokefalos*, *Neosteneosaurus* and *Andrianavoay*). However, within new topology, there are still areas of uncertainty, as indicated by low resolution between earlier members of Machimosaurini (*Yvridiosuchus* and *Lemmysuchus*) and intermediate non-machimosaurins (*Neosteneosaurus* and *Andrianavoay*). Chapter V then explores the evolutionary history of teleosauroids using this new phylogeny, focusing on their species richness, ecomorphology and distribution over time.

Finally, in Chapter VI, the wastebasket taxon '*Steneosaurus*' is revised; firstly, a thorough investigation of the historical context of the genus is made. The type specimen *S. rostromajor* (MNHN.RJN 134c-d), represented by a partially preserved rostrum, is then re-described and compared with other relevant teleosauroid taxa ('*S.*' *baroni*, *Myc. nasutus*; '*S.' leedsi*; '*S.' heberti*; and '*S.' edwardsi*). While MNHN.RJN 134c-d shares certain characters with all aforementioned species, it also lacks features that are unique to these species; this could be because MNHN.RJN 134c-d is a poorly preserved partial rostrum, and many rostral characters within teleosauroids are plastic (this is one reason why MNHN.RJN 134c-d does not

function as a suitable type specimen). By the process of elimination, the taxon that MNHN.RJN 134c-d can most likely be referred to is '*S*.' *edwardsi*; however, due to terrible preservation, 'weak' characters and uncertainty of ontogenetic stages and sexual dimorphism within teleosauroids, I cannot confidently refer MNHN.RJN 134c-d to this taxon. Therefore, despite being the most commonly used genus with a 188-year-old history as well as previously encompassing multiple species, I allocate MNHN.RJN 134c-d as a *nomen dubium* and consider the genus *Steneosaurus* as undiagnostic.

ADDITIONAL WORK

Throughout the length of my PhD, I was involved in several studies with colleagues. The first major project was that by Foffa et al. (2019), in which the species '*Steneosaurus*' *megarhinus* was re-described and given the new generic name *Bathysuchus*. In addition to morphological comparisons, Foffa et al. (2019) used quantitative methods (humerus:femur and tibia:femur measurements) to determine that the then-most closely related taxon to *Bathysuchus*, *Aeolodon*, was more pelagic than other teleosauroids. The second work I participated in was the re-description of *Mystriosaurus laurillardi* and '*Steneosaurus*' *brevior* with Sachs et al. (2019b). The authors resurrected the generic name *Mystriosaurus* Kaup, 1834, demonstrated it to be a valid genus, and merged '*S*.' *brevior* into this taxon. Lastly, I was involved in a small project with a Tunisian colleague (Dridi & Johnson, in press), briefly describing fragmentary Callovian Tunisian teleosauroid material and discussing teleosauroid biogeography during this period in time. I am also currently involved with the re-description of *Peipehsuchus teleorhinus* (IVPP RV 48001) and the Chinese teleosauroid (which was previously referred to as *Peipehsuchus*; IVPP V 10098), with colleagues Eric Wilberg (SBU), Yi Hongyu and Jianye Chen (IVPP). In addition, Davide Foffa (NMSc) and I plan to begin a re-description of *Mycterosuchus nasutus* (NHMUK PV R 2617) in the autumn of this year, as well as attempt to examine available *Sericodon* material (Porrentruy, Switzerland) for quantitative comparisons with *Aeolodon*.

I have also begun to work on quantitatively assessing teleosauroid ecomorphological feeding throughout their history, with Davide Foffa (NMSc), Mark Young and Stephen Brusatte (UoE) . This study was based on Foffa et al. (2018a), in which the authors examined the dietary ecology of three main groups of marine reptiles (plesiosaurians, ichthyosaurians and thalattosuchians) during a specific time period (~161.5–157.3 mya) in the Jurassic. Using specific tooth measurements, Foffa et al. (2018a) were able to assign these fossil taxa to various dietary guilds (initially proposed by Massare, 1987), and found that ecosystems during the Jurassic were characterized by high niche partitioning and spatial variation in dietary ecology. After reading this fascinating publication, I decided to investigate the overall ecological diversity of Teleosauroidea, as it has never before been explored (likely due to their instable alpha taxonomy and phylogenetics). I focused specifically on teleosauroids, including members from all areas of the updated phylogenetic tree and spanning the entirety of their evolutionary history (~189-127 mya). As explored in Chapter V, teleosauroids may be compartmentalized into distinct 'ecomorphotypes' based on their osteological anatomy: longirostrine specialist, longirostrine generalist, mesorostrine generalist, pelagic specialist, semi-terrestrial and macrophagous/durophagous.

As in Foffa et al. (2018a), I used morphological and functional cranio-dental characteristics. This cranio-dental dataset (Appendix S3.1) built upon the teleosauroids listed in Foffa et al. (2018a), adding 25 more specimens and 11 species. Overall, the dataset amassed 38 teleosauroid specimens, either as isolated teeth or individual specimens with preserved in situ dentition, and included the genera *Plagiophthalmosuchus*, *Platysuchus*, *Mycterosuchus*, *Proexochokefalos*, *Charitomenosuchus*, *Neosteneosaurus*, *Machimosaurus*, *Lemmysuchus*, *Aeolodon*, *Bathysuchus*, *Sericodon*, *Indosinosuchus*, *Mystriosaurus*, *Deslongchampsina*, *Yvridiosuchus*, *Macrospondylus* and *Teleosaurus*, as well as *Machimosaurus* and '*Steneosaurus*' sp. All genera were initially assembled into 'subgroups' (excluding the basal teleosauroid *Plagiophthalmosuchus*) and are grouped as follows: eight teleosaurids (*Platysuchus*, *Mycterosuchus*, *Aeolodon*, *Bathysuchus*, *Sericodon*, *Indosinosuchus*, *Mystriosaurus*, *Teleosaurus*), five

'primitive' machimosaurids (*Proexochokefalos*, *Charitomenosuchus*, *Neosteneosaurus*, *Deslongchampsina*, *Macrospondylus*) and three derived machimosaurins (*Yvridiosuchus*, *Lemmysuchus*, *Machimosaurus*). Six continuous and 13 discrete cranio-dental characters, modified from Foffa et al. (2018a), were used (Appendix S3.2). A principal component analysis (PCA) was conducted using RStudio in R version 3.5.2 (RStudio Team, 2012; Racine, 2012; R Core Team, 2014). The preliminary results produced (Fig. 1) show that the first PCA (PC1, 45.9%) and second PCA (PC2, 11.9%) partially support the grouping of anatomical teleosauroid ecomorphotypes, and display four key factors: (1) *Plagiophthalmosuchus* is separate from the remaining taxa; (2) machimosaurins cluster together along PC1; (3) the majority of teleosaurids cluster in two main pockets along PC1 and somewhat PC2; and (4) 'primitive' machimosaurins are spread across both PC1 and PC2. Currently, these results suggest that most teleosauroids, excluding machimosaurins, either had overlapping morphologies and/or overlapped within certain habitats.

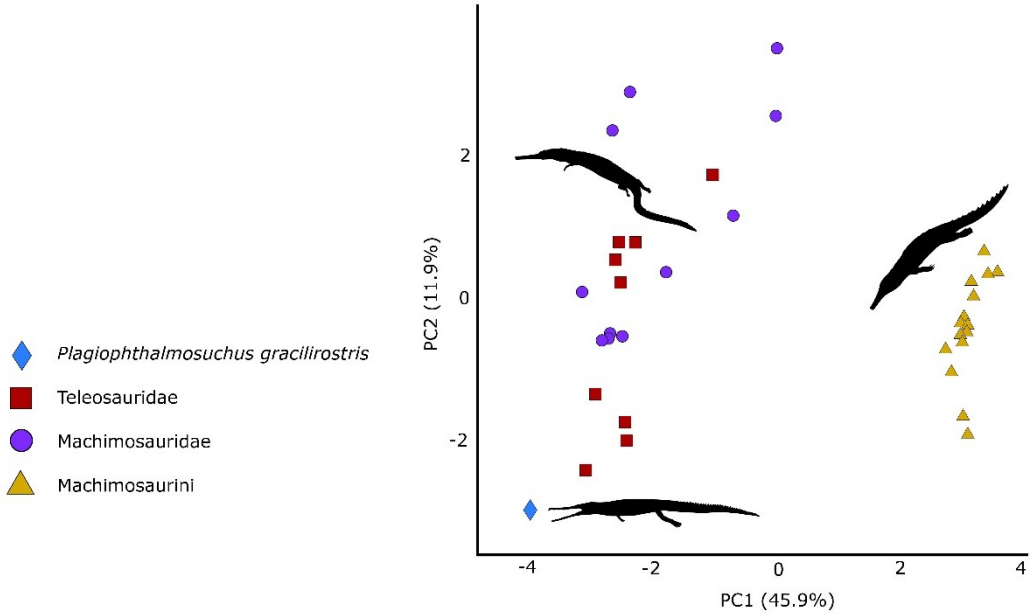

Figure 1. Principal component analysis (PCA) of PC1 and PC2 showing preliminary results of the ecological distribution of teleosauroid groups. Silhouettes made available by PhyloPic (http://phylopic.org/): images by S. Hartmann, G. Monger and N. Tamura.

However, much work remains to be done. For example, the aforementioned taxa will be separated into time bins, to examine if there is a geographical or age trend in the feeding ecology, and will also be tested on palaeohabitat to examine if there is a different trend. A third PCA will be

statistically assessed, and a canonical variates analysis (CVA) will be undertaken. In addition, specific characters of the mandible will be measured and incorporated into the analysis, and this is currently being discussed with D. Foffa (NMSc).

FUTURE RESEARCH

A comprehensive phylogenetic framework, coupled with stable interpretations of alpha taxonomy, is essential for examining macroevolutionary trends through time, regardless of fossil clade. Now that a relatively clear and highly supported topology for Teleosauroidea has provided, investigations into topics such as their feeding, ecological structuring, body sizes and growth patterns, ontogeny and near-global distributional strategies can begin. There is still much to learn concerning these crocodylomorphs, one of the most successful and innovative clades within the group; understanding their phylogenetic relationships is only the tip of the iceberg.

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APPENDIX S1.1

ONLINE SUPPLEMENTARY MATERIAL FOR:

Re-description of two contemporaneous mesorostrine teleosauroids (Crocodylomorpha, Thalattosuchia) from the Bathonian of England, and insights into the early evolution of Machimosaurini

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S1) CrocSuperMatrix Project Overview

S2) Hastings + Young (H+Y) dataset

S2.1) H+Y dataset – general information and scoring sources of the OTUs

S2.2) H+Y dataset – character list

S3) Character and OTUs breakdowns of the merged, and parent, datasets

S4) Supplementary References

S5) List of institutional abbreviations

S1) CrocSuperMatrix Project Overview

Thus far two datasets have been successfully merged, those of Alexander Hastings and Mark Young (see Ristevski *et al*., 2018). This has formed the Hastings and Young dataset (referred to herein as the H+Y matrix).

Currently, four datasets are in the process of being merged. The first two are the H+Y dataset and a modified version of the Andrade *et al*. (2011) dataset (herein referred to as the mA matrix). The first iteration of the H+Y and mA matrices were published in Ristevski *et al*. (2018).

The third dataset, is a modification of the dataset published by Wilberg (2017), (herein referred to as the mW matrix). Note that Ősi *et al*. (2018) was the first paper to have all three of these datasets together, however therein the Wilberg (2017) dataset had not been re-structured to be the same as H+Y and mA datasets. Note that here we have done so, and also created two new sub-sections: 1) internal neuroanatomy, sensory systems and cranial exocrine glands, and 2) craniomandibular pneumaticity.

A fourth dataset has also been added, a modification of the dataset recently published by Leardi *et al*. (2017), herein referred to as the mL matrix. This is an expansion of the dataset first published by Clark *et al*. (2000), and recently elaborated upon by Pol *et al*. (2013) and Leardi *et al*. (2017).

The characters for both datasets have been organised into a common anatomical order, and broken down into the same 20 sub-sections:

1) skull geometry and dimensions
2) craniomandibular ornamentation
3) internal neuroanatomy, sensory systems and cranial exocrine glands
4) craniomandibular pneumaticity
5) rostral neurovascular foramina
6) cranial rostrum
7) skull roof
8) orbit and temporal region
9) palate and perichoanal structures
10) occipital
11) braincase, basicranium and suspensorium
12) mandibular geometry
13) mandible
14) dentition and alveolar morphologies
15) axial post-cranial skeleton
16) appendicular skeleton: pectoral girdle and forelimbs
17) appendicular skeleton: pelvic girdle and hind limbs
18) dermal ossifications: osteoderms
19) dermal ossifications: gastralia
20) soft tissue

Herein we only use the H+Y dataset, as a larger paper on this project is currently in preparation.

S2) Hastings + Young (H+Y) dataset

S2.1) H+Y dataset – general information and scoring sources of the OTUs

The present list includes information for each operational taxonomic unit (OTU) included in the matrix. Fragmentary taxa (i.e. ones that are highly incomplete) are mentioned as: [fragmentary taxon].

OUTGROUP TAXON

RAUISUCHIDAE (1 OTU)

(1) *Postosuchus kirkpatricki* Chatterjee, 1985
DATA FROM: Nesbitt (2011), Weinbaum (2011), Weinbaum (2013).
LOCALITY: Post (=Miller) Quarry, Texas, USA.
FORMATION: Cooper Canyon Formation, Dockum Group.
AGE: Norian, Late Triassic.

INGROUP TAXA

BASAL CROCODYLOMORPHS (= 'SPHENOSUCHIANS' *SENSU LATO*) (5 OTUs)

(2) *Dromicosuchus grallator* Sues *et al*., 2003
DATA FROM: Sues *et al*. (2003), Nesbitt (2011).
LOCALITY: West Genlee, Durham County, North Carolina, USA.
FORMATION: Mudstone of Lithofacies Association II, Newark Super-Group. South-central region of Durham sub-basin of Deep River Basin.
AGE: upper Carnian or lower Norian, Late Triassic.

(3) *Hesperosuchus* cf. *agilis*
DATA FROM: CM 29894; Clark *et al*. (2000), Nesbitt (2011).
LOCALITY: *Coelophysis* Quarry, Ghost Ranch, northern New Mexico, USA.
FORMATION: "siltstone member", Chinle Formation.
AGE: upper Norian–?Rhaetian, Late Triassic.

(4) *Terrestrisuchus gracilis* Crush, 1984
DATA FROM: Crush (1984), Nesbitt (2011).
LOCALITY: Pant-y-ffynon Quarry, Cowbridge, Glamorgan, Wales, UK.
FORMATION: fissure fills in Carboniferous limestone.
AGE: ?Rhaetian, Late Triassic.

(5) *Dibothrosuchus elaphros* Simmons, 1965
DATA FROM: Wu (1986); Nesbitt (2011).
LOCALITY: Huangchiatien, Lufeng, Yunnan, China.
FORMATION: Zhangjiawa Formation, Lower Lufeng Group.
AGE: Sinemurian–Pliensbachian, Lower Jurassic.

(6) *Junggarsuchus sloani* Clark *et al*., 2004
DATA FROM: photographs of the holotype provided by Eric Wilberg; Clark *et al*. (2004).
LOCALITY: Wucaiwan, Altay Prefecture, Xinjiang Province, NW China.
FORMATION: lower part of the Shishugou Formation (= Wucaiwan Formation).
AGE: Bathonian–Callovian, Middle Jurassic.

BASAL CROCODYLIFORMS: 'PROTOSUCHIANS' *SENSU LATO* (4 OTUs)

(7) *Hemiprotosuchus leali* Bonaparte, 1971
DATA FROM: Bonaparte (1971).
LOCALITY: Quebrada de los Jachaleros, W La Rioja Province, Argentina.
FORMATION: Los Colorados Formation.
AGE: Coloradense, Norian, Upper Triassic.

(8) *Protosuchus richardsoni* Brown, 1933
DATA FROM: Colbert & Mook (1951), Nesbitt (2011).
LOCALITY: Ward's Terrace, Arizona, USA.
FORMATION: upper half of the Moenave Formation, Glen Canyon Group.
AGE: Hettangian, Lower Jurassic.

(9) *Protosuchus haughtoni* (Busbey & Gow, 1984)
DATA FROM: Gow (2000), Nesbitt (2011).
LOCALITY: South Africa.
FORMATION: Upper Elliot Formation.
AGE: Lower Jurassic.

(10) *Eopneumatosuchus colberti* Crompton & Smith, 1980
DATA FROM: Crompton & Smith (1980); high-resolution images of the holotype provided by Lawrence Witmer.
LOCALITY: 11 miles NE of Cameron, Coconino County, Arizona, USA.
FORMATION: 'Silty facies', Kayenta Formation, Glen Canyon Group.
AGE: Sinemurian-Pliensbachian, Lower Jurassic.

BASAL CROCODYLIFORMS: SHARTEGOSUCHIDAE (1 OTU)

(11) *Fruitachampsa callisoni* Clark, 2011
DATA FROM: Clark (2011).
LOCALITY: Fruita, Colorado, USA.
FORMATION: Morrison Formation.
AGE: Upper Jurassic.

NOTOSUCHIA: 'NOTOSUCHIDAE' (2 OTUs)

(12) *Notosuchus terrestris* Woodward, 1896
DATA FROM: MACN-Pv-N-22, MACN-Pv-N-23, MACN-Pv-N-24, MACN-Pv-N-43, MACN-Pv-N-107, MACN-Pv-RN-1015, MACNPv-RN-1037, MACN-Pv-RN-1038, MACN-Pv-RN-1039, MACN-Pv-RN-1040, MACN-Pv-RN-1041, MACN-Pv-RN-1043, MACN-Pv-RN-1044, MACN-Pv-RN-1045, MACN-Pv-RN-1046, MACN-Pv-RN-1047, MACN-Pv-RN-1048, MACN-Pv-RN-1118, MACN-Pv-RN-1119, MLP-64-IV-16-1, MLP-64-IV-16-5(253) (lectotype), MLP-64-IV-16-6(203), MLP-64-IV-16-7(219), MLP-64-IV-16-8(209), MLP-64-IV-16-9(201), MLP-64-IV-16-10(221), MLP-64-IV-16-11, MLP-64-IV-16-12, MLP-64-IV-16-13, MLP-64-IV-16-14, MLP-64-IV-16-15, MLP-64-IV-16-16, MLP-64-IV-16-17, MLP-64-IV-16-18, MLP-64-IV-16-20, MLP-64-IV-16-21, MLP-64-IV-16-22, MLP-64-IV-16-23, MLP-64-IV-16-24, MLP-64-IV-16-25, MLP-64-IV-16-28, MLP-64-IV-16-30, MLP-64-IV-16-31(206), MPCA-Pv-528; MPCA-Pv-789/1; MPCA-Pv-791; Woodward (1896), Gasparini (1971), Bonaparte (1991, 1996), Andrade & Bertini (2008b), Fiorelli & Calvo (2008).

LOCALITES: several outcrops in the Neuquén and Rio Negro provinces, Argentina
FORMATION: Bajo de La Carpa Formation, Neuquén Group. Neuquén Basin.
AGE: Santonian–Campanian, Upper Cretaceous.

(13) *Mariliasuchus amarali* Carvalho & Bertini, 1999
DATA FROM: MN-6298-V, MN-6756-V, UFRJ-DG-50-R(type), UFRJ-DG-56-R, UFRJ-DG-105-R, UFRJ-DG-106-R, UFRJ-DG-115-R, URC-R-67, URC-R-68, URC-R-69; Carvalho & Bertini (1999), Andrade (2005), Vasconcellos & Carvalho (2005).
LOCALITY: Rio do Peixe, São Paulo State, Brazil.
FORMATION: Aracatuba Formation, Bauru Group. Bauru Basin.
AGE: Campanian, Upper Cretaceous.

NOTOSUCHIA: SPHAGESAURIDAE (3 OTUs)
(14) *Adamantinasuchus navae* Nobre & Carvalho, 2006
DATA FROM: UFRJ-DG-107-R (type), UFRJ-DG-216-R; Nobre & Carvalho (2006).
LOCALITY: Rio do Peixe, São Paulo State, Brazil.
FORMATION: Aracatuba Formation, Bauru Group. Bauru Basin.
AGE: Campanian, Upper Cretaceous.

(15) *Sphagesaurus huenei* Price, 1950
DATA FROM: Pol (2003).
LOCALITY: N São Paulo State, Brazil.
FORMATION: Adamantina Formation, Bauru Group. Bauru Basin.
AGE: Campanian–Maastrichtian, Upper Cretaceous.

(16) *Caipirasuchus montealtensis* (Andrade & Bertini, 2008a)
DATA FROM: Andrade (2005), Andrade & Bertini (2008a), Iori *et al*. (2016).
LOCALITY: Monte Alto, N São Paulo State, Brazil.
FORMATION: Adamantina Formation, Bauru Group. Bauru Basin.
AGE: Campanian–Maastrichtian, Upper Cretaceous.

NOTOSUCHIA: BAURUSUCHIDAE (1 OTU)
(17) *Baurusuchus pachecoi* Price, 1945
DATA FROM: FEF-R-1-9; Price (1945), Carvalho *et al.* (2005; MPMA 62-0001-02).
LOCALITY: 72 km SW of Vila do Veadinho (type locality), Paulo de Faria city. and several other localities spread at the N-NW São Paulo State, Brazil.
FORMATION: Adamantina Formation, Bauru Group. Bauru Basin.
AGE: Campanian-Maastrichtian, Upper Cretaceous.
OBSERVATION: Here *B. salgadoensis* Carvalho *et al.* 2005 is treated as a subjective junior synonym of *B. pachecoi*.

NOTOSUCHIA: 'URUGUAYSUCHIDAE' (1 OTU)
(18) *Araripesuchus patagonicus* Ortega *et al.*, 2000
DATA FROM: MUCPv-267, MUCPv-268, MUCPv-269 (holotype); Ortega *et al.* (2000).

LOCALITY: El Chocon (Embalse Ezequiel Ramos Mexia), Neuquén Province, NW Patagonia, W Argentina.
FORMATION: Candeleros Member, Rio Limay Formation, Neuquén Group. Neuquén Basin.
AGE: Albian-Cenomanian, 'mid' Cretaceous.

NOTOSUCHIA: PEIROSAURIDAE (2 OTUs)

(19) *Montealtosuchus arrudacamposi* Carvalho *et al*., 2007
DATA FROM: Carvalho *et al.* (2007)
LOCALITY: Monte Alto, N São Paulo State, Brazil.
FORMATION: Adamantina Formation, Bauru Group. Bauru Basin.
AGE: Campanian–Maastrichtian, Upper Cretaceous.

(20) *Uberabasuchus terreficus* Carvalho *et al*., 2004
DATA FROM: Carvalho *et al.* (2004).
LOCALITY: Caieira outcrop, Peiropolis, Uberaba Municipality, S Minas Gerais State, SE Brazil.
FORMATION: Marilia Formation, Bauru Group. Bauru Basin.
AGE: Campanian–Maastrichtian, Upper Cretaceous.

NOTOSUCHIA: 'TREMATOCHAMPSIDAE' (1 OTU)

(21) cf. *Hamadasuchus rebouli* Buffetaut, 1994
DATA FROM: This OTU was scored for specimens referred to *H. rebouli* by Larsson & Sues (2007; mainly ROM-52620), not the type material. Therefore, the use of cf. *H. rebouli*.
LOCALITY: SE Morocco.
FORMATION: Kem Kem beds.
AGE: Albian–Cenomanian, 'mid' Cretaceous.

NOTOSUCHIA: SEBECIDAE (1 OTU)

(22) *Sebecus icaeorhinus* Simpson, 1937
DATA FROM: AMNH 3160 (cast); Larsson & Sues (2007).
LOCALITY: Canadon Hondo and Canadon Vaca, tributaries to the Rio Chico del Chubut, Chubut, Patagonia, Argentina.
FORMATION: Casamayor Formation.
AGE: early–middle Eocene, Paleogene.

NOTOSUCHIA: MAHAJANGASUCHIDAE (1 OTU)

(23) *Mahajangasuchus insignis* Buckley & Brochu, 1999
DATA FROM: Buckley & Brochu (1999), Turner & Buckley (2008).
LOCALITY: 1km SW Berivotra Village, SW Mahajanga, NW Madagascar.
FORMATION: Maevarano Formation. Mahajanga Basin.
AGE: Campanian–Maastrichtian, Upper Cretaceous.

NEOSUCHIA: ATOPOSAURIDAE (2 OTUs)

(24) *Alligatorium meyeri* Gervais, 1871
DATA FROM: photographs of the holotype provided by Jon Tennant.
LOCALITY: Cerin, France.
FORMATION: Cerin Lagerstätte.
AGE: upper Kimmeridgian, Upper Jurassic.

(25) *Theriosuchus pusillus* Owen, 1878
DATA FROM: NHMUK PV OR 48216 (lectotype), NHMUK PV OR 48330 (paratype), NHMUK PV OR 48262; Tennant *et al*. (2016).
LOCALITY: Durlston Bay, Swanage, Dorset County, Jurassic Coast, S-SW England, UK.
FORMATION: "Beccles' residuary marls" (beds 83–93; Clements, 1993), Worbarrow Tout Member (sensu Westhead & Mather, 1996), Lulworth Formation, Purbeck Limestone Group.
AGE: Berriasian, Lower Cretaceous.

NEOSUCHIA: GONIOPHOLIDIDAE (8 OTUs)

(26) *Eutretauranosuchus delfsi* Mook, 1967
DATA FROM: CM 8028 (holotype); Smith *et al*. (2010).
LOCALITY: Canon City, Colorado, USA.
FORMATION: Morrison Formation. Morrison Basin.
AGE: Kimmeridgian, Upper Jurassic.

(27) *Amphicotylus stovalli* (Mook, 1964)
DATA FROM: CMC VP7798 (cast).
LOCALITY: V97, Cimarron County, Oklahoma, USA.
FORMATION: Morrison Formation.
AGE: ?Kimmeridgian, Upper Jurassic.

(28) *Goniopholis baryglyphaeus* Schwarz, 2002
DATA FROM: Schwarz (2002).
LOCALITY: Guimarota coal mine, Leiria, Portugal.
FORMATION: Lower lignite coal layer (`Fundschichten'), `Guimarota Strata', Alcobaca Formation.
AGE: Kimmeridgian, Upper Jurassic.

(29) *Goniopholis kiplingi* Andrade *et al*., 2011.
DATA FROM: DORCM 12154 (holotype); Andrade *et al*. (2011).
LOCALITY: Durlston Bay, Swanage, Dorset County, Jurassic Coast, SSW England, UK.
FORMATION: Bed 129b (Clements 1993), Intemarine beds (sensu Wimbledon, 1995), Stair Hole Member (sensu Westhead & Mather 1996), Durlston Formation, Purbeck Limestone Group.
AGE: Berriasian, Lower Cretaceous.

(30) *Goniopholis simus* Owen, 1878
DATA FROM: NHMUK PV OR 41098 (type), NHMUK PV R 5814.
LOCALITIES: Swanage, Dorset County, Jurassic Coast, S-SW England; further referred materials from Schaumburg-Lippe Region, NW Germany.
FORMATIONS: Purbeck Limestone Group (UK) and Obernkirchen Sandstone, Buckeburg Member (Germany).
AGE: Berriasian, Lower Cretaceous.

(31) *Anteophthalmosuchus hooleyi* Salisbury & Naish, 2011
DATA FROM: NHMUK PV R 3876 (holotype); Salisbury & Naish (2011).
LOCALITY: near the "Tie Pits", Atherfield Point, Isle of Wight, UK.

FORMATION: Shepherd's Chine Member, Vectis Formation, Wealden Group.
AGE: Barremian to early Aptian, Lower Cretaceous.

(32) *Anteophthalmosuchus epikrator* Ristevski *et al*., 2018.
DATA FROM: IWCMS 2001.446, IWCMS 2005.127; Martin *et al*. (2016).
LOCALITY: Hanover Point, Isle of Wight, UK.
FORMATION: upper part of Wessex Formation, Wealden Group.
AGE: Barremian, Lower Cretaceous.

TETHYSUCHIA: PHOLIDOSAURIDAE (11 OTUs)

(33) *Elosuchus cherifensis* (Lavocat, 1955)
DATA FROM: MNHN.F MRS 340, MNHN Escuillé collection; de Lapparent de Broin (2002), Meunier & Larsson (2016).
LOCALITY: Hamadas, Morocco.
FORMATION: Kem Kem beds, Ifezouanae and Aoufous Formations.
AGE: Cenomanian, Upper Cretaceous.

(34) *Elosuchus broinae* Meunier & Larsson, 2016
DATA FROM: MNHN.F SAM 129 (holotype), de Lapparent de Broin (2002); Meunier & Larsson (2016).
LOCALITY: Gara Samani, Algeria.
FORMATION: unnamed formation.
AGE: upper Albian, Lower Cretaceous.

(35) *Vectisuchus leptognathus* Buffetaut & Hutt, 1980
DATA FROM: SMNS 50984 (holotype).
LOCALITY: Isle of Wight, UK.
FORMATION: Vectis Formation, Wealden Group. Wessex Sub-basin.
AGE: Barremian–?early Aptian, Lower Cretaceous.

(36) *Pholidosaurus schaumburgensis* von Meyer, 1841
DATA FROM: casts of the Koken (1887) specimens (including MB.R.1965, MB.R.1966, MB.R.1970.304); the natural external and internal moulds of Bückeburg specimens (MB.R.2025.1, two MB.R.unumbered specimens); Koken, 1887.
LOCALITY: quarry near Harrel im Furstentum, Schaumburg-Lippe Region, NW Germany.
FORMATION: Obernkirchen Member, Bückeburg Formation.
AGE: Berriasian, Lower Cretaceous.
OBSERVATION: Only specimens from the Bückeburg Formation are used to score this OTU.

(37) *Pholidosaurus* sp. (Charente)
DATA FROM: Martin *et al*. (2016b).
LOCALITY: Cherves-de-Cognac, Carrière de Champblanc, Charente Department, SW France.
FORMATION: Horizon C36.
AGE: Berriasian, Lower Cretaceous.

(38) *Meridiosaurus vallisparadisi* Fortier *et al*., 2011

DATA FROM: Fortier *et al*. (2011).
LOCALITY: Valle Edén locality, near Tacuarembó city, Uruguay.
FORMATION: fluviolacustrine sandstone facies of the Batoví Member, Tacuarembó Formation
AGE: ?Kimmeridgian-Tithonian, Upper Jurassic.

(39) *Chalawan thailandicus* (Buffetaut & Ingavat, 1980)
DATA FROM: Buffetaut & Ingavat (1980), Martin *et al*. (2014).
LOCALITIES: Nong Bua Lam Phu (type locality) and Kham Phok, NE Thailand.
FORMATION: upper part of Phu Kradung Formation, Khorat Group. Khorat Basin.
AGE: Early Cretaceous.

(40) *Sarcosuchus hartti* (Marsh, 1896) [fragmentary taxon]
DATA FROM: NHMUK PV R 3423; Buffetaut & Taquet (1977).
LOCALITY: outcrop in the vicinity of Setubal, Bahia State, NE Brazil.
FORMATION: unclear.
AGE: Lower Cretaceous.
OBSERVATION: This OTU is scored solely for the lower jaw referred to *S. hartti* by Buffetaut & Taquet (1977).

(41) *Sarcosuchus imperator* de Broin & Taquet, 1966
DATA FROM: MNHN.F GDF 662; de Broin & Taquet (1966), Buffetaut & Taquet (1977), Sereno *et al.* (2001).
LOCALITY: outcrop in the vicinities of the Gadoufaoua, Agadez Province, Niger.
FORMATION: Elrhaz Formation. Tegama Basin.
AGE: Aptian, Lower Cretaceous.

(42) cf. *Terminonaris robusta* Mook, 1934
DATA FROM: Wu *et al*. (2001b), Larsson & Sues (2007).
LOCALITY: SMNH locality 63E04-001, approximately 5km east of Highway 23, the southern bank of the Carrot River, southwest of the Pasquia Hills, Saskatchewan, Canada.
FORMATION: Keld Member, Favel Formation.
AGE: upper Cenomanian? to lower Turonian, Upper Cretaceous.
OBSERVATION: This OTU is based solely on the Canadian material referred to *T. robusta*.

(43) *Oceanosuchus boecensis* Hua *et al*., 2007
DATA FROM: Hua *et al*. (2007), Lepage *et al*. (2008).
LOCALITY: La Boëce, near Mortagne-au-Perche, Orne, Vasse-Normandie, France.
FORMATION: base of hard-ground Coulimer 2.
AGE: lower Cenomanian, Upper Cretaceous.

TETHYSUCHIA: BASAL DYROSAUROIDEA (2 OTUs)
(44) *Pholidosaurus purbeckensis* (Mansel-Pleydell, 1888)
DATA FROM: DORCM G.27, DORCM G.97 (holotype), NHMUK PV OR 28432, NHMUK PV R 3414, NHMUK PV R 3956, NHMUK PV R 36721.

LOCALITY: type locality unclear, thought to be Isle of Purbeck, UK.
FORMATION: Purbeck Formation, Purbeck Limestone Group.
AGE: Berriasian, Lower Cretaceous.

(45) *Fortignathus felixi* Young *et al*., 2016 [fragmentary taxon]
DATA FROM: MNHN.F INA 21, MNHN.F INA 22, MNHN.F INA 25 (holotype).
LOCALITY: West of In Abangharit, Agadez District, Niger.
FORMATION: Echkar Formation, Tegma Series.
AGE: upper Albian to lower Cenomanian, 'mid' Cretaceous.

TETHYSUCHIA: DYROSAURIDAE (15 OTUs)

(46) *Acherontisuchus guajiraensis* Hastings *et al*., 2011 [fragmentary taxon]
DATA FROM: UF/IGM 34 (holotype), UF/IGM 35, UF/IGM 36, UF/IGM 37, UF/IGM 38 & UF/IGM 39; Hastings *et al*. (2011).
LOCALITY: below Coal Seam 85 in the La Puente Pit, Cerrejón coal mine, Guajira Department, north-eastern Colombia.
FORMATION: Cerrejón Formation.
AGE: middle–late Paleocene, Palaeogene.

(47) *Anthracosuchus balrogus* Hastings *et al*., 2015
DATA FROM: UF/IGM 67 (holotype), UF/IGM 68 (paratype), UF/IGM 69 & UF/IGM 70; Hastings *et al*. (2015).
LOCALITY: clay layer below Coal Seam 90 in the La Puente Pit, Cerrejón coal mine, Guajira Department, north-eastern Colombia.
FORMATION: Cerrejón Formation.
AGE: middle–late Paleocene, Palaeogene.

(48) *Arambourgisuchus khouribgaensis* Jouve *et al*., 2005a.
DATA FROM: Jouve *et al*. (2005a).
LOCALITY: Phosphate mine in 'Sidi Chenane' area, in NE part of Ouled Aboun Basin, Morocco.
FORMATION: couche (= bed/layer) 2a.
AGE: Thanetian, Paleocene, Palaeogene.

(49) *Atlantosuchus coupatezi* Buffetaut, 1979
DATA FROM: Jouve *et al*. (2008).
LOCALITY: 'Sidi Chenane' area, in NE part of Ouled Aboun Basin, Morocco.
FORMATION: not given.
AGE: Danian, Paleocene, Palaeogene.

(50) *Cerrejinosuchus improcerus* Hastings *et al*., 2010
DATA FROM: UF/IGM 29 (holotype), UF/IGM 30, UF/IGM 31 & UF/IGM 32; Hastings *et al*. (2010).
LOCALITY: clay layer below Coal Seam 90 in the La Puente Pit, Cerrejón coal mine, Guajira Department, north-eastern Colombia.
FORMATION: Cerrejón Formation.
AGE: middle–late Paleocene, Palaeogene.

(51) *Chenanisuchus lateroculi* Jouve *et al*., 2005b

DATA FROM: Jouve *et al*. (2005b).
LOCALITY: 'Sidi Chenane' area, in NE part of Ouled Aboun Basin, Morocco.
FORMATION: couche (= bed/layer) 2a.
AGE: Thanetian, Paleocene, Palaeogene.

(52) *Congosaurus bequaerti* Dollo, 1914
DATA FROM: Jouve & Schwarz (2004), Schwarz *et al.* (2006), Schwarz-Wings *et al.* (2009).
LOCALITY: Cacongo, Cabinda Province, Angola.
FORMATION: Bed no. 8.
AGE: Danian, Paleocene, Palaeogene.

(53) *Dyrosaurus maghribensis* Jouve *et al*., 2006
DATA FROM: Jouve *et al.* (2006).
LOCALITY: phosphate mine of Mera el Arech, in Oulad Abdoun Basin, Morocco.
FORMATION: couche (= bed/layer) 1.
AGE: Ypresian, lower Eocene, Palaeogene.

(54) *Dyrosaurus phosphaticus* (Thomas, 1893)
DATA FROM: MNHN.F ALG 1, MNHN.F ALG 2; Jouve (2005).
LOCALITIES: north of Djebel Teldj, near Metlaoui, Tunisia and Tébessa, north-east Algeria.
FORMATION: "phosphate layer" (Tunisia).
AGE: Ypresian, lower Eocene, Palaeogene.

(55) *Guarinisuchus munizi* Barbosa *et al*., 2008
DATA FROM: Barbosa *et al.* (2008).
LOCALITY: Poty Quarry, Paulista, NE of Pernambuco State, Brazil.
FORMATION: Maria Farinha Formation. Paraiba Basin.
AGE: upper Danian, Lower Paleocene, Palaeogene.

(56) *Hyposaurus rogersii* Owen, 1849
DATA FROM: Troxell (1925), Denton *et al*. (1997).
LOCALITIES: Numerous, including: Inversand Company Marl Pit, Gloucester County, New Jersey, USA; Santee rediversion canal, St. Stephen, Berkeley County, South Carolina, USA.
FORMATION: Hornerstown Formation (NJ), Williamsburg Formation (SC).
AGE: Maastrichtian, Upper Cretaceous (NJ), upper Paleocene, Palaeogene (SC).

(57) *Phosphatosaurus gavialoides* Bergounioux, 1955
DATA FROM: Buffetaut (1978), Hill *et al*. (2008).
LOCALITY: near Metlaoui, Tunisia and 'Mali-20', south of Tamaguélet, Tilemsi valley region, Mali.
FORMATION: "phosphate layer" (Tunisia) and unnamed formation in Taoudeni Basin (Mali).
AGE: Ypresian, lower Eocene, Palaeogene.

(58) *Rhabdognathus keiniensis* Jouve, 2007.

DATA FROM: Jouve (2007).
LOCALITY: Cheit Keini and In Farghas, Tilemsi valley region, Mali.
FORMATION: unnamed formation in Taoudeni Basin.
AGE: Paleocene, Palaeogene.

(59) *Rhabdognathus aslerensis* Jouve, 2007
DATA FROM: Brochu *et al*. (2002), Jouve (2007).
LOCALITY: 'Mali-5', near Asler, north-west of Tamaguélet, Tilemsi valley region, Mali.
FORMATION: unnamed formation in Taoudeni Basin.
AGE: Maastrichtian or Paleocene.

(60) *Sabinosuchus coahuiliensis* Shiller *et al*., 2016 [fragmentary taxon]
DATA FROM: Shiller *et al*. (2016).
LOCALITY: El Rancho Soledad, Coahuila, Mexico.
FORMATION: Escondido Formation.
AGE: Maastrichtian, Upper Cretaceous.

(61) *Sokotosuchus ianwilsoni* Halstead, 1975
DATA FROM: Buffetaut (1979).
LOCALITY: Sokoto area, NW Nigeria.
FORMATION: Dukamaje Formation.
AGE: Maastrichtian, Upper Cretaceous.

NEOSUCHIA: BERNISSARTIIDAE (2 OTUs)
(62) *Bernissartia fagesii* Dollo, 1883
DATA FROM: Norell & Clark (1990).
LOCALITY: Sainte-Barbe coal mine, Bernissart, Belgium.
FORMATION: Sainte-Barbe Clays Formation.
AGE: Berriasian–Barremian, Lower Cretaceous.

(63) *Koumpiodontosuchus aprosdokiti* Sweetman *et al*., 2015
DATA FROM: IWCMS 2012.203 and IWCMS 2012.204 (holotype), Sweetman *et al*. (2015).
LOCALITY: The foreshore near Yaverland, SE coast of Isle of Wight, UK.
FORMATION: from one of the plant debris beds occurring between beds 26 and 38, Wessex Formation.
AGE: Barremian, Lower Cretaceous.

NEOSUCHIA: SUSISUCHIDAE (2 OTUs)
(64) *Susisuchus anatoceps* Salisbury *et al*., 2003
DATA FROM: SMNK PAL3804 (holotype); Salisbury *et al.* (2003, 2006).
LOCALITY: Araripe Plateau, NE Brazil.
FORMATION: Crato Member, Santana Formation. Araripe Basin.
AGE: Aptian–Albian, Lower Cretaceous.

(65) *Isisfordia duncani* Salisbury *et al*., 2006
DATA FROM: Salisbury *et al.* (2006; QM-F-36211, QM-F-44320).
LOCALITY: outcrop near Isisford, Queensland, Australia.
FORMATION: Winton Formation.
AGE: Albian–Cenomanian, 'mid' Cretaceous.

EUSUCHIA: HYLAEOCHAMPSIDAE *SENSU LATO* (3 OTUs)

(66) *Iharkutosuchus makadii* Ősi *et al*., 2007
DATA FROM: MTM 2006.52.1 (holotype), MTM 2006.53.1, MTM PAL 2013.51.1, MTM PAL 2013.58.1; Ősi *et al*. (2007), Ősi (2008), Ősi (2014).
LOCALITY: Iharkút, Bakony Mountains, western Hungary.
FORMATION: Csehbánya Formation.
AGE: Santonian, Upper Cretaceous.

(67) *Pachycheilosuchus trinquei* Rogers, 2003
DATA FROM: Rogers (2003); osteoderms re-scored based on Buscalioni *et al*. (2011).
LOCALITY: SMU locality 331, Erath County, Texas, USA.
FORMATION: Glen Rose Formation.
AGE: Albian, Lower Cretaceous.

(68) *Pietraroiasuchus ormezzanoi* Buscalioni *et al*., 2011
DATA FROM: Buscalioni *et al*. (2011).
LOCALITY: locality of 'Civita di Pietraroia', Mt Matese, southern Italy.
FORMATION: 'Civita di Pietraroia Cave'.
AGE: lower Albian, Lower Cretaceous.

EUSUCHIA: CROCODYLIA (4 OTUs)

(69) *Gavialis gangeticus* (Gmelin, 1879)
DATA FROM: comparative collection held in the Palaeontology and Zoology departments of NHMUK.
DISTRIBUTION: river systems of Brahmaputra, Indus, Ganges, Mahanadi; Burma, Buthan, India, Nepal and Pakistan.
AGE: extant – Holocene, Quaternary.

(70) *Crocodylus niloticus* (Laurenti, 1768)
DATA FROM: comparative collection held in the Palaeontology and Zoology departments of NHMUK; and in the Life Sciences Faculty, Ohio University.
DISTRIBUTION: river systems of several African countries, especially the Nile River, Egypt.
AGE: extant – Holocene, Quaternary.

(71) *Crocodylus porosus* (Schneider, 1801)
DATA FROM: comparative collection held in the Palaeontology and Zoology departments of NHMUK; and in the Life Sciences Faculty, Ohio University.
DISTRIBUTION: freshwater to brackish areas of several countries, from SE Asia to Australia.
AGE: extant – Holocene, Quaternary.

(72) *Alligator mississippiensis* (Daudin, 1802)
DATA FROM: NHMUK ZD 290, NHMUK ZD 1973-2-21-2, NHMUK ZD 1974-3010, NHMUK ZD 1975-1424, NHMUK ZD II-1-I.
DISTRIBUTION: swamp to low-energy river systems of SE USA, most noticeably in Florida.

AGE: extant – Holocene, Quaternary.

THALATTOSUCHIA: TELEOSAUROIDEA (18 OTUs)

(73) *Aeolodon priscus* (von Sömmerring, 1814)
DATA FROM: NMHUK PV R 1086 (holotype), MNHN.F CNJ 78a.
LOCALITIES: Daiting, S Germany, and Canjuers, Var, France.
FORMATION: Mörnsheim Formation (type locality) and Canjuers consveration Lagerstätte.
AGE: lower Tithonian, Upper Jurassic.

(74) *Machimosaurus buffetauti* Young *et al*., 2015
DATA FROM: SMNS 91415 (holotype); Young *et al*. (2014).
LOCALITY: Am Hörnle Quarry, Neuffen, Baden-Württemberg, Germany.
FORMATION: Lacunosamergel Formation.
AGE: *Ataxioceras hypselocyclum* Sub-Mediterranean ammonite Zone (=Weißer Jura gamma 2), lower Kimmeridgian, Upper Jurassic.
OBSERVATION: The correct nominal authority is the short taxonomic note Young *et al*., 2015 not Young *et al*. 2014 (where the new taxon was described).

(75) *Machimosaurus hugii* von Meyer, 1837
DATA FROM: MG-8730-1, Young *et al*. (2014).
LOCALITY: Kreuzen Quarry at St. Verena, near Solothurn, Canton Solothurn, Switzerland (lectotype locality) and Guimarota coal mine, Leiria, NW Portugal.
FORMATION: Solothurn Turtle Limestone, Reuchenette Formation (lectotype locality) and Guimarota Strata, Alcobaça Formation.
AGE: Kimmeridgian, Upper Jurassic.

(76) *Machimosaurus mosae* Sauvage & Liénard, 1879
DATA FROM: IRSNB (cast of neotype), Hua (1999), Young *et al*. (2014).
LOCALITY: beach near Ambleteuse, Boulonnais, Département du Pas-de-Calais, Nord Pas-de-Calais, France (neotype locality).
FORMATION: Argiles de Châtillon Formation (neotype locality).
AGE: From either the *Aulacostephanus autissiodorensis* Sub-Boreal ammonite Zone, uppermost Kimmeridgian, or the *Gravesia gigas*/*Pectinaties elegans* Sub-Boreal ammonite Zone, lowermost Tithonian; Upper Jurassic (neotype locality).

(77) *Machimosaurus rex* Fanti *et al*., 2016
DATA FROM: ONM-NG-1 (holotype), Fanti *et al*. (2016).
LOCALITY: Touil el Mhahir, Tataouine Governorate, Tunisia.
FORMATION: Douiret Sand Member, Douiret Formation.
AGE: Hauterivian, Lower Cretaceous.

(78) *Mycterosuchus nasutus* Andrews, 1913
DATA FROM: NHMUK PV R 2617 (holotype), CAMSM J.1420, Andrews (1913).
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.

AGE: middle Callovian, Middle Jurassic.

(79) Chinese teleosauroid skull referred to *Peipehsuchus teleorhinus* by Li (1993)
DATA FROM: IVPP V 10098.
LOCALITY: Daxian, Szechuan, China.
FORMATION: Ziliujing Formation.
AGE: Lower Jurassic.

(80) *Platysuchus multiscrobiculatus* (Berckhemer, 1929)
DATA FROM: SMNS 9930 (holotype), MNHNL TU895.
LOCALITY: Holzmaden, Baden-Württemberg, Germany.
FORMATION: Posidonia Shale Formation.
AGE: lower Toarcian, Lower Jurassic.

(81) *Steneosaurus bollensis* (von Jäger, 1828)
DATA FROM: GPIT-RE-9427, MMG BwJ 595 (holotype), MMG BwJ 689, NHMUK PV R 324, NHMUK PV R 756, NHMUK PV R 1088, NHMUK PV R 5703, NHMUK PV OR 14436, NHMUK PV OR 14438, SMNS 849, SMNS 9427, SMNS 9428, SMNS 17484, SMNS 20280, SMNS 20283, SMNS 53422, unnumbered OUMNH partial skull.
LOCALITIES: Baden-Württemberg, Germany; Yorkshire, UK.
FORMATION: Posidonia Shale Formation (Germany) and Whitby Mudstone Formation (UK).
AGE: lower Toarcian, Lower Jurassic.

(82) *Steneosaurus brevior (*Blake, 1876)
DATA FROM: NHMUK PV OR 14781 (holotype).
LOCALITY: Whitby, Yorkshire, UK.
FORMATION: Mulgrave Shale Member, Whitby Mudstone Formation, Lias Group.
AGE: *Harpoceras serpentinum* Sub-Boreal ammonite Zone, lower Toarcian, Lower Jurassic.

(83) *Steneosaurus edwardsi* Eudes-Deslongchamps, 1868a
DATA FROM: NHMUK PV R 2074, NHMUK PV R 2865, NHMUK PV R 3701, PETMG R175, PETMG R178, Andrews (1913).
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(84) *Steneosaurus gracilirostris* Westphal, 1961
DATA FROM: NHMUK PV OR 14792 (holotype), NHMUK PV OR 15500 (paratype), MNHNL TU515.
LOCALITY: Whitby, Yorkshire, UK.
FORMATION: Alum Shale Member, Whitby Mudstone Formation, Lias Group.
AGE: *Hildoceras bifrons* Sub-Boreal ammonite Zone, lower Toarcian, Lower Jurassic.

(85) *Deslongchampsina larteti* Eudes-Deslongchamps, 1866
DATA FROM: OUMNH J.29851 (neotype).
LOCALITY: Enslow Bridge, Oxfordshire, UK.
FORMATION: Cornbrash Formation, Great Oolite Group.
AGE: Bathonian, Middle Jurassic.

(86) *Steneosaurus leedsi* Andrews, 1909
DATA FROM: NHMUK PV R 2619, NHMUK PV R 3320 (holotype), NHMUK PV R 3806.
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(87) *Steneosaurus heberti* Morel de Glasville, 1876
DATA FROM: MNHN.F 13.1890 (holotype).
LOCALITY: Villers-sur-mer, Calvados, France.
FORMATION: Marnes de Dives Formation.
AGE: upper Callovian, Middle Jurassic.

(88) *Yvridiosuchus boutilieri* Eudes-Deslongchamps, 1868
DATA FROM: OUMNH J.1401 (neotype), OUMNH J.1403, OUMNH J.29850, OUMNH 1404.
LOCALITY: Enslow Bridge, Oxfordshire, UK.
FORMATION: Cornbrash Formation, Great Oolite Group.
AGE: Bathonian, Middle Jurassic.

(89) *Lemmysuchus obtusidens* (Andrews, 1909) Johnson *et al*., 2017
DATA FROM: NHMUK PV R 3168 (holotype), LPP.M.21, NOTNH FS3361, PETMG R39.
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(90) *Teleosaurus cadomensis* (Lamouroux, 1820)
DATA FROM: MNHN.F AC 8746, MNHN.F RJN 464, NHMUK PV OR 119, NHMUK PV OR 32588, NHMUK PV OR 32657, NHMUK PV OR 32680, casts: NHMUK PV R 880 and NHMUK PV R 880a; Eudes-Deslongchamps (1867-69); Jouve (2009).
LOCALITY: Allemagne, 3km south of Caen, Calvados, Normandy, France.
FORMATION: “Calcaire de Caen”.
AGE: Bathonian, Middle Jurassic.

(91) *Bathysuchus megarhinus* Hulke, 1871 (Foffa et al., in press)
DATA FROM: NHMUK PV OR 43086 (holotype), DORCM G.05067i-v, Vignaud (1995).
LOCALITY: Kimmeridge, Dorset, UK.
FORMATION: Dorset succession, lower Kimmeridge Clay Formation, Ancholme Group.

AGE: *Aulacostephanus autossiodorensis* Sub-Boreal ammonite Zone, upper Kimmeridgian, Upper Jurassic.

THALATTOSUCHIA: BASAL METRIORHYNCHOIDAE (8 OTUs)

(92) *Eoneustes bathonicus* (Mercier, 1933) Young *et al*., 2010
DATA FROM: Mercier (1933).
LOCALITY: Port-en-Bessin, Calvados, Normandy, France.
FORMATION: “Calcaire de Caen”.
AGE: Bathonian, Middle Jurassic.

(93) *Eoneustes gaudryi* (Collot, 1905) Young *et al*., 2010
DATA FROM: NHMUK PV R 3353 (holotype).
LOCALITY: Saint-Seine-l'Abbaye, Département du Cote d'Or, Bourgogne, France.
FORMATION: “Calcaires blancs jaunâtres des de Bourgogne”.
AGE: lower Bathonian, Middle Jurassic.

(94) *Magyarosuchus fitosi* Ősi *et al*., 2018
DATA FROM: MTM V.97 (holotype).
LOCALITY: eastern Gerecse Mountains, Hungary.
FORMATION: Bed 13, uppermost Kisgerecse Marl Formation.
AGE: *Grammoceras striatulum* ammonite Subzone, *Grammoceras thouarense* ammonite Zone, upper Toarcian, Early Jurassic.

(95) Metriorhynchoidea indeterminate (Chile) [fragmentary taxon]
DATA FROM: Gasparini *et al*. (2000).
LOCALITY: Quebrada La Iglesia, Copiapo, Central-east Chile.
FORMATION: upper part of the Lautaro Formation.
AGE: lower Bajocian, Middle Jurassic.

(96) *Zoneait nargorum* Wilberg, 2015a
DATA FROM: Wilberg (2015a).
LOCALITY: near Suplee, Oregon, USA.
FORMATION: Weberg Member, Snow-shoe Formation.
AGE: uppermost Aalenian or lowermost Bajocian, Middle Jurassic.

(97) *Peipehsuchus teleorhinus* Young, 1948 [fragmentary taxon]
DATA FROM: photographs of the holotype provided by Eric Wilberg.
LOCALITY: Beipei, Szechuan, China.
FORMATION: Ziliujing Formation.
AGE: Lower Jurassic.
OBSERVATION: This OTU is solely based on the holotype, with the skull referred to *Peipehsuchus teleorhinus* treated as a separate OTU.

(98) *Pelagosaurus typus* Bronn, 1841
DATA FROM: BRLSI M.1415, BRLSI M.1416, BRLSI M.1420, MNHN.F RJN 463, MTM V.52.2516, NHMUK PV OR 19735, NHMUK PV OR 32599, SMNS 8666, SMNS 17758, SMNS 50374, SMNS 80066; Pierce & Benton (2006).
LOCALITIES: Numerous, including: Amaye-sur-Orne, Caen, and Curcy, France; Nabern near Kirchheim, S Germany; Holzmaden, Bad Boll,

Ohmden and Ohmdenhausen, Swabian Jura, S Germany; Ilminster, Somerset, UK; Whitby, Yorkshire, England.
FORMATIONS: Numerous, including: Posidonia Shale Formation (Germany) and Whitby Mudstone Formation (UK).
AGE: lower Toarcian, Lower Jurassic.
OBSERVATION: this OTU includes *P. moorei* as a subjective junior synonym of *P. typus*, following Pierce & Benton (2006).

(99) *Teleidosaurus calvadosii* (Eudes-Deslongchamps, 1866)
DATA FROM: NHMUK PV R 2619 (plastoholotype); Eudes-Deslongchamps (1867-69).
LOCALITY: Allemagne, 3km south of Caen, Calvados, Normandy, France.
FORMATION: "Calcaire de Caen".
AGE: Bathonian, Middle Jurassic.

THALATTOSUCHIA: METRIORHYNCHIDAE: METRIORHYNCHINAE (19 OTUs)

(100) '*Dakosaurus*' *lissocephalus* Seeley, 1869
DATA FROM: CAMSM J29419 (holotype).
LOCALITY: Ely, Cambridgeshire, UK
FORMATION: lower Kimmeridge Clay Formation, Ancholme Group.
AGE: upper Kimmeridgian, Upper Jurassic.

(101) *Cricosaurus araucanensis* (Gasparini & Dellapé, 1976) Young & Andrade, 2009
DATA FROM: MLP-72-IV-7-1 (holotype), MLP-72-IV-7-2; Gasparini & Dellapé (1976), Fernández & Gasparini (2000, 2008), Fernández & Herrera (2009), Herrera *et al.* (2009).
LOCALITY: Argentina.
FORMATION: Vaca Muerta Formation, Mendoza Group. Neuquén Basin.
AGE: lower Tithonian, Upper Jurassic.

(102) *Cricosaurus bambergensis* sp. nov.
DATA FROM: NKMB-P-Watt14/274.
LOCALITY: Wattendorf quarry, Wattendorf, Bayern, Germany.
FORMATIONS: Wattendorf Member, Torleite Formation.
AGE: *Aulacostephanus eudoxus* Tethys ammonite Zone, upper Kimmeridgian, Upper Jurassic.

(103) *Cricosaurus elegans* (Wagner, 1852) Wagner, 1858
DATA FROM: BSPG AS I 504.
LOCALITY: Daiting, near Monheim, Bayern, Germany.
FORMATIONS: Mörnsheim Formation.
AGE: *Hybonoticeras hybonotum* Tethys ammonite Zone, lower Tithonian, Upper Jurassic.

(104) *Cricosaurus lithographicus* Herrera *et al.*, 2013
DATA FROM: Herrera *et al*. (2013).
LOCALITY: El Ministerio Quarry, Los Catutos Area, Zapala Department, Neuquén Province, Argentina.

FORMATION: Los Catutos Member, Vaca Muerta Formation, Mendoza Group. Neuquén Basin.
AGE: upper lower or middle upper Tithonian, Upper Jurassic.

(105) '*Cricosaurus*' *macrospondylus* (Koken, 1883) Young & Andrade, 2009
DATA FROM: Hua *et al*. (2000).
LOCALITY: Barret-le-Bas, Département du Hautes-Alpes, Provence-Alpes-Côte d'Azur, France.
FORMATION: not given.
AGE: *Busnardoites campylotoxus* ammonite Zone, lower Valanginian, Lower Cretaceous.
OBSERVATION: This OTU is solely based on the French referred specimen.

(106) '*Cricosaurus*' *saltillensis* (Buchy *et al*., 2006) Young & Andrade, 2009
DATA FROM: Buchy *et al*. (2006); Buchy *et al*. (2013).
LOCALITY: Sierra de Buñuelas, near Gomez Farías, State of Coahuila, Mexico.
FORMATION: La Caja Formation.
AGE: lower Tithonian, Upper Jurassic.

(107) *Cricosaurus schroederi* (Kuhn, 1936) Young & Andrade, 2009
DATA FROM: Karl *et al*. (2006b); photographs of the holotype provided by Nils Knötschke.
LOCALITY: Sachsenhagen, Lower Saxony, Germany.
FORMATION: '*Platylenticeras* beds'.
AGE: lower Valanginian, Lower Cretaceous.

(108) *Cricosaurus suevicus* (Fraas, 1901) Young & Andrade, 2009
DATA FROM: SMNS 9808 (lectotype), SMNS 90513; Fraas (1901, 1902).
LOCALITY: Nusplingen, Zollernalbkreis, Baden-Württemberg, Germany.
FORMATION: Nusplingen Plattenkalk.
AGE: *Hybonoticeras beckeri* Tethys ammonite Zone (= Malm Zeta 1), upper Kimmeridgian, Upper Jurassic.

(109) *Cricosaurus* sp. (Cuba)
DATA FROM: Gasparini & Iturralde-Vinent (2001).
LOCALITY: Viñales Valley, western Cuba.
FORMATION: Jagua Vieja Member, Jagua Vieja Formation.
AGE: middle or upper Oxfordian, Upper Jurassic.

(110) *Cricosaurus vignaudi* (Frey *et al*., 2002) Young & Andrade, 2009
DATA FROM: Frey *et al*. (2002).
LOCALITY: Mazatepec, State of Puebla, Mexico.
FORMATION: La Pimienta Formation.
AGE: 'middle' Tithonian, Upper Jurassic.

(111) *Gracilineustes acutus* (Lennier, 1887) Young *et al*., 2010
DATA FROM: Lennier (1887).
LOCALITY: Cap de la Hève, *Département du* Seine-Maritime, Haute-Normandie, France.
FORMATION: Marnes de Bléville Formation.

AGE: *Rasenia cymodoce* Sub-Boreal ammonite Zone, lower Kimmeridgian, Upper Jurassic.

(112) *Cricosaurus sp.* (Painten taxon)
DATA FROM: BMMS-BK 1-2.
LOCALITY: Rygol quarry, Painten, Bayern, Germany.
FORMATION: Arnstorf Member, Torleite Formation.
AGE: Hybonoticeras beckeri Tethys ammonite Zone (= Malm Zeta 1), upper Kimmeridgian, Upper Jurassic.

(113) *Gracilineustes leedsi* (Andrews, 1913) Young *et al*., 2010
DATA FROM: CAMSM J64297, GLAHM V973, GLAHM V974, GLAHM V975, PETMG R24, PETMG R72, NHMUK PV R 2031, NHMUK PV R 2042, NHMUK PV R 3014, NHMUK PV R 3015, NHMUK PV R 3540 (holotype), NHMUK PV R 3899, NHMUK PV R 5793.
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(114) *Maledictosuchus riclaensis* Parrilla-Bel *et al*., 2013
DATA FROM: Parrilla-Bel *et al*. (2013).
LOCALITY: ‘‘Barranco de la Paridera’’, Ricla, Zaragoza, Spain.
FORMATION: Ágreda Formation.
AGE: *Erymnoceras coronatum* Sub-Mediterranean ammonite Zone, Middle Callovian, Middle Jurassic.

(115) Metriorhynchinae indeterminate (Cuba) [fragmentary taxon]
DATA FROM: USNM 419640.
LOCALITY: Viñales Valley, western Cuba.
FORMATION: Jagua Vieja Member, Jagua Vieja Formation.
AGE: middle or upper Oxfordian, Upper Jurassic.

(116) *Metriorhynchus geoffroyii* von Meyer, 1832 [fragmentary taxon]
DATA FROM: MHNG V-2232 (holotype).
LOCALITY: Le Havre, Département de Seine-Maritime, Haute-Normandie, France.
FORMATION: not given.
AGE: Kimmeridgian, Upper Jurassic.

(117) '*Metriorhynchus*' *palpebrosus* (Phillips, 1871)
DATA FROM: OUMNH J.29823 (holotype).
LOCALITY: Shotover Hill, Oxfordshire, UK.
FORMATION: Kimmeridge Clay Formation.
AGE: most likely lower Tithonian, Upper Jurassic.

(118) *Metriorhynchus superciliosus* (de Blainville, 1853)
DATA FROM: AMNH 997, GLAHM V942, GLAHM V963, GLAH V964, GLAHM V965, GLAHM V966, GLAHM V971, GLAHM V982, GLAHM V983, GLAHM V984, GLAHM V985, GLAHM V987, GLAHM V988, GLAHM V989, GLAHM V996, GLAHM V1004, GLAHM V1015, GLAHM

V1027, GLAHM V1140, GLAHM V1142, GLAHM V1143, NHMUK PV R 1666, NHMUK PV R 2030, NHMUK PV R 2032, NHMUK PV R 2036, NHMUK PV R 2044, NHMUK PV R 2051, NHMUK PV R 2053, NHMUK PV R 2054, NHMUK PV R 2055, NHMUK PV R 2058, NHMUK PV R 2067, NHMUK PV R 3900, NHMUK PV R 6859, NHMUK PV R 6860, PETMG R10, PETMG R17, PETMG R18, PETMG R20, PETMG R42, PETMG R180, RMS M150, SMNS 10115, SMNS 10116, SMNS 81689; Andrews (1913).
LOCALITIES: outcrops from England and France.
FORMATIONS: Primarily: Oxford Clay Formation and Marnes de Dives Formation.
AGE: lower Callovian to lower Oxfordian, Middle-Upper Jurassic.

(119) *Rhacheosaurus gracilis* von Meyer, 1831
DATA FROM: AMNH 4804 and NHMUK PV R3961 (plastoholotypes), NHMUK PV R 3948.
LOCALITIES: Daiting (type locality) and Eichstätt, S Germany.
FORMATIONS: Mörnsheim Formation (type locality) and Solnhofen Formation.
AGE: *Hybonoticeras hybonotum* Tethys ammonite Zone, lower Tithonian, Upper Jurassic.

THALATTOSUCHIA: METRIORHYNCHIDAE: GEOSAURINAE (24 OTUs)

(120) cf. *Torvoneustes* [fragmentary taxon]
DATA FROM: MANCH J6459.
LOCALITY: Headington, Oxfordshire, UK.
FORMATION: most likely Beckley Sand Member, Kingston Formation.
AGE: middle Oxfordian, Upper Jurassic.

(121) *Dakosaurus andiniensis* Vignaud & Gasparini, 1996
DATA FROM: Gasparini *et al.* (2006), Pol & Gasparini (2009).
LOCALITIES: in the provinces of Neuquén and Mendoza, Argentina.
FORMATIONS: Vaca Muerta Formation, Mendoza Group and Neuquén Group. Neuquén Basin.
AGE: upper Tithonian, Upper Jurassic. Possibly also Berriasian, Lower Cretaceous.

(122) *Dakosaurus maximus* (Plieninger, 1846)
DATA FROM: NHMUK PV OR 33186, NHMUK PV OR 35766, NHMUK PV OR 35835-7, SMNS 8203 (neotype), SMNS 80148, SMNS 82043; Plieninger, 1846, Young & Andrade (2009), Andrade (2010), Andrade *et al.* (2010).
LOCALITIES: Numerous outcrops in England, Germany and France.
FORMATIONS: Numerous, including: Kimmeridge Clay Formation, Solnhofen Formation, Mergelstätten Formation and Nusplingen Plattenkalk.
AGE: upper Kimmeridgian-lower Tithonian, Upper Jurassic.

(123) Geosaurinae indeterminate (Argentina) [fragmentary taxon]
DATA FROM: Gasparini *et al*. (2005).
LOCALITY: Chacay Melehue, Neuquén Province, Argentina.

FORMATION: Los Molles Formation.
AGE: upper Bathonian, Middle Jurassic.

(124) *Geosaurus giganteus* (von Sömmerring, 1816)
DATA FROM: NHMUK PV R 1229 (holotype), NHMUK PV R 1230, NHMUK PV OR 37016, NHMUK PV OR 37020; Young & Andrade (2009), Andrade (2010), Andrade *et al.* (2010).
LOCALITIES: Daiting (type locality) and Eichstätt, Southern Germany.
FORMATIONS: Mörnsheim Formation (type locality) and Solnhofen Formation.
AGE: *Hybonoticeras hybonotum* Tethys ammonite Zone, lower Tithonian, Upper Jurassic.

(125) *Geosaurus grandis* (Wagner, 1858)
DATA FROM: BSPG AS-VI-1 (holotype); Young & Andrade (2009), Andrade (2010), Andrade *et al.* (2010).
LOCALITY: Daiting, near Monheim, Bayern, Germany.
FORMATIONS: Mörnsheim Formation.
AGE: *Hybonoticeras hybonotum* Tethys ammonite Zone, lower Tithonian, Upper Jurassic.

(126) *Geosaurus lapparenti* (Debelmas & Strannoloubsky, 1957)
DATA FROM: Debelmas (1952), Debelmas & Strannoloubsky (1957).
LOCALITY: La Martre, Département du Var, Provence-Alpes-Côte d'Azur, France.
FORMATION: not given.
AGE: *Neocomites peregrinus* ammonite Zone, upper Valanginian, Lower Cretaceous.

(127) *Ieldraan melkshamensis* Foffa *et al.*, 2017
DATA FROM: NHMUK PV OR 46797.
LOCALITY: Melksham, Wiltshire, UK.
FORMATION: Oxford Clay Formation, Ancholme Group.
AGE: Callovian, Middle Jurassic.

(128) '*Metriorhynchus*' *brachyrhynchus* (Eudes-Deslongchamps, 1868c)
DATA FROM: GLAHM V978, GLAHM V995, NHMUK PV R 3541, NHMUK PV R 3699, NHMUK PV R 3700 (neotype), NHMUK PV R 3804, NHMUK PV R 4763, PETMG R19.
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(129) '*Metriorhynchus*' *casamiquelai* Gasparini & Chong, 1977
DATA FROM: Gasparini & Chong (1977).
LOCALITY: Quebrada Sajasa, Región de Antofagasta, Chile.
FORMATION: not given.
AGE: Callovian, Middle Jurassic.

(130) Chouquet cf. '*Metriorhynchus*' *hastifer*

DATA FROM: Lepage *et al*. (2008).
LOCALITY: Octeville-sur-Mer, Département du Seine-Maritime, Haute-Normandie, France.
FORMATION: Marnes de Bléville Formation.
AGE: *Rasenia cymodoce* Sub-Boreal ammonite Zone, lower Kimmeridgian, Upper Jurassic.

(131) '*Metriorhynchus*' *westermanni* Gasparini, 1980
DATA FROM: Gasparini *et al*. (2008), Fernández *et al*. (2011).
LOCALITY: Placilla de Caracoles (type locality), and Sierra del Medio, Región de Antofagasta, Chile
FORMATION: Mina Chica Formation (type locality) and Vergara Formation.
AGE: Callovian and Oxfordian, Middle and Upper Jurassic.

(132) Mr Leeds' dakosaur
DATA FROM: NHMUK PV R 3321, NHMUK PV R 4696, NHMUK PV R 4763.
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(133) Mr Passmore's Specimen
DATA FROM: OUMNH J1583.
LOCALITY: Swindon, Wiltshire, UK.
FORMATION: upper Kimmeridge Clay Formation.
AGE: lower Tithonian, Upper Jurassic.

(134) *Neptunidraco ammoniticus* Cau & Fanti, 2011
DATA FROM: Cau & Fanti (2011).
LOCALITY: unknown, but near Sant'Ambrogio di Valpolicella, Verona, Italty.
FORMATION: pseudonodular facies of lowermost Rosso Ammonitico Veronese Formation.
AGE: *Parkinsonia parkinsoni* ammonite Zone, uppermost Bajocian, Middle Jurassic.

(135) *Plesiosuchus manselii* (Hulke, 1870)
DATA FROM: NHMUK PV OR 40103 and NHMUK PV OR 40103a (holotype), NHMUK PV R 1089, MJML K181, MJML K434.
LOCALITIES: Westbury, Wiltshire; and Kimmeridge, Dorset (type locality), England, UK.
FORMATION: Kimmeridge Clay Formation, Ancholme Group.
AGE: *Aulacostephanus eudoxus* Sub-Boreal ammonite Zone, upper Kimmeridgian, to *Pectinatites wheatleyensis* Sub-Boreal ammonite Zone, lower Tithonian, Upper Jurassic.

(136) *Purranisaurus potens* Rusconi, 1948
DATA FROM: Herrera et al. (2015); high quality photographs of the holotype by Yanina Herrera.
LOCALITY: Arroyo del Arroyo del Cajón Grande, southwest Malargüe Department, Mendoza Province, Argentina.

FORMATION: Vaca Muerta Formation, Mendoza Group. Neuquén Basin.
AGE: *Substeueroceras koeneni* ammonite Zone, upper Tithonian or lower Berriasian, Upper Jurassic or Lower Cretaceous.

(137) *Suchodus durobrivensis* Lydekker, 1890
DATA FROM: NHMUK PV R 1994 (holotype), NHMUK PV R 2039
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(138) *Torvoneustes carpenteri* (Wilkinson *et al.*, 2008)
DATA FROM: BRSMG Ce 17365 (holotype), BRSMG Cd 7203; Wilkinson *et al.* (2008), Andrade (2010), Andrade *et al.* (2010).
LOCALITY: Westbury, Wiltshire, England, UK.
FORMATION: lower Kimmeridge Clay Formation, Ancholme Group.
AGE: *Aulacostephanus eudoxus* Sub-Boreal ammonite Zone, upper Kimmeridgian, Upper Jurassic.

(139) *Torvoneustes coryphaeus* Young *et al*., 2013b
DATA FROM: MJML K1863 (holotype).
LOCALITY: Swindon, Wiltshire, UK.
FORMATION: lower Kimmeridge Clay Formation, Ancholme Group.
AGE: *Pictonia baylei* Sub-Boreal ammonite Zone, lower Kimmeridgian, Upper Jurassic.

(140) *Torvoneustes mexicanus* (Wieland, 1910) [fragmentary taxon]
DATA FROM: Barrientos-Lara *et al*. (2016).
LOCALITY: inprecise, but likley near Tlaxiaco, Oaxaca, Mexico.
FORMATION: suggested to be Sabinal Formation.
AGE: suggested to be Kimmeridgian, Upper Jurassic.

(141) *Torvoneustes* sp. [fragmentary taxon]
DATA FROM: MJML K1707.
LOCALITY: Kimmeridge Bay, Dorset, UK.
FORMATION: Dorset succession, lower Kimmeridge Clay Formation, Ancholme Group.
AGE: *Aulacostephanus autossiodorensis* Sub-Boreal ammonite Zone, upper Kimmeridgian, Upper Jurassic.

(142) *Tyrannoneustes lythrodectikos* Young *et al*., 2013a
DATA FROM: GLAHM V972 (holotype), GLAHM V1145, NHMUK PV R 3939, PETMG R176.
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(143) Vaches Noire dakosaur
DATA FROM: MNHN.F RJN 134a, ME 2012.4.68.
LOCALITY: Vaches Noires cliffs, Calvados, France

FORMATION: Marnes de Villers Formation (possibly also Marnes de Dives Formation).
AGE: ?Callovian and Oxfordian, Middle? and Upper Jurassic.

S2.2) H+Y dataset – character list

The character list (460 characters) for the Hastings + Young (H+Y) dataset used for one of the phylogenetic analyses herein. The characters are organised into the anatomical order listed in section S1. Comments on the characters and scoring are in italics, and precede the description of states. Osteological craniomandibular and dental characters constitute 73.261% (337/460) of the character list, osteological post-cranial characters contribute 25.652% (118/460), while soft-tissue characters contribute 1.087% (5/460).

Characters that are not applicable (i.e. cannot be scored) for all taxa are marked with an asterisk **(*)** following the character description. Characters treated as additive for the ordered-character analysis are denoted by **(ORDERED)** following the character description.

Abbreviations: ch., character; **ds**, dataset; **mod.**, modified; **rev.**, revised.

Skull geometry and dimensions (Ch. 1 – 10; 2.174% of characters)

#	Description
1	**Skull height, in posterior view:** *Clark (1994, ch. 3 mod.); Andrade & Bertini (2008a, ch. 2); Andrade et al. (2011, ch. 1); Ristevski et al. (2018, ds 1, ch. 1); Smith et al. (in review, ds 2, ch. 1); Ősi et al. (2018, ds 1, ch. 1).* 0. skull higher than wide, or subequal 1. skull evidently wider than high
2	**Skull geometry, relative position of tooth row, quadrate articular facet and occipital condyle:** *Wu & Sues (1996, ch. 24 mod.); Sereno et al. (2003, ch. 46 mod.); Pol (2003, ch. 104 mod.); Turner & Buckley (2008, ch. 105 mod.); Andrade et al. (2011, ch. 2); Ristevski et al. (2018, ds 1, ch. 2); Smith et al. (in review, ds 2, ch. 2); Ősi et al. (2018, ds 1, ch. 2).* *In its original format, this character assumed that the tooth row was always below the occipital condyle, which is not always true (e.g.* Pelagosaurus typus*). The original format was modified by Andrade et al. (2011) because in Mesoeucrocodylia each of its components (height of occipital condyle, quadrate condyle and tooth row) will relate to each other independently, therefore demanding more than the original three states to reflect their geometric relationships. Note also differences from the original scorings, and also the lack of agreement on the scorings by different authors, for the original format.* 0. tooth row and quadrate condyle aligned, both at a lower level than the occipital condyle 1. tooth row at a lower level than the quadrate condyle, which is aligned to the occipital condyle 2. tooth row quadrate and occipital condyle all aligned in the same plane 3. tooth row and occipital condyle aligned, but quadrate condyle at a slightly lower level 4. tooth row and quadrate condyle unaligned and quadrate at a lower level, but both below the occipital condyle 5. tooth row and quadrate condyle unaligned and tooth row at a lower level, but both below the occipital condyle
3	**Skull geometry, relative position of tooth row and occipital condyle:** *Wu & Sues (1996, ch. 24 mod.); Sereno et al. (2003, ch. 46 mod.); Pol (2003, ch. 104 mod.); Turner & Buckley (2008, ch. 105 mod.); Andrade et al. (2011, ch. 3); Ristevski et al. (2018, ds 1, ch. 3); Smith et al. (in review, ds 2, ch. 3); Ősi et al. (2018, ds 1, ch. 3).* 0. unaligned, tooth row at a lower level than occipital condyle 1. tooth row and occipital condyle aligned in the same plane
4	**Skull geometry, relative position of quadrate condyles and occipital condyle:** *Wu & Sues (1996, ch. 24 mod.); Sereno et al. (2003, ch. 46 mod.); Pol (2003, ch. 104 mod.); Turner & Buckley (2008, ch. 105 mod.); Andrade et al. (2011, ch. 4); Young et al. (2016, ds 2, ch. 148), Ristevski et al. (2018, ds 2, ch. 6); Smith et al. (in review, ds 1, ch. 7); Ősi et al. (2018, ds 1, ch. 4).* *State (1) occurs in Neosuchia (with reversals in marine crocodyliforms, e.g. Dyrosauridae and cf.* Terminonaris robusta*).* 0. unaligned, quadrate condyles are at a lower level than the occipital condyle

	1. quadrate condyles and occipital condyle aligned on the same plane
5	**Skull width to length ratio:** *Young et al. (2012, ch. 1); Young (2014, ch. 1); Young et al. (2016, ds 2, ch. 1); Ristevski et al. (2018, ds 2, ch. 1); Smith et al. (in review, ds 1, ch. 1); Ősi et al. (2018, ds 1, ch. 5).* *= maximum width between the lateral-most points of the quadrates : basicranial length* 0. 0.26 or lower 1. between 0.27 and 0.4 2. 0.4 or greater
6	**Snout elongation:** *Jouve (2005, ch. 5 mod.); Hastings et al. (2010, ch. 1 mod.); Ristevski et al. (2018, ds 2, ch. 2); Smith et al. (in review, ds 1, ch.2); Ősi et al. (2018, ds 1, ch. 6).* *State (2) can only be scored for taxa where snout elongation is the result of the anteroposterior elongation of the maxilla (with the maxillae contact along their medial margins along the dorsal surface).* *State (1) occurs in most pholidosaurids, most dyrosaurids and gavialoids.* *State (2) occurs in Thalattosuchia and* Meridiosaurus*.* 0. both the nasals and maxillae not elongated 1. nasals and maxillae both elongated (having the sublongirostrine or longirostrine condition) 2. maxillae elongated, contacting each other along their medial margins. No elongation of the nasals (having the sublongirostrine or longirostrine condition)
7	**Rostrum, relation between height and width: (ORDERED)** *Clark (1994, ch. 3 mod.); Young (2006, ch. 8 mod.); Wilkinson et al. (2008, ch. 25 mod.); Young & Andrade (2009, ch. 25 mod.); Andrade et al. (2011, ch. 6 mod.); Young et al. (2011, ch. 25 mod.); Young et al. (2013a, ch. 1 mod.); Young et al. (2012, ch. 2 mod.); Young (2014, ch. 2 mod.); Young et al. (2016, ds 2, ch. 2 mod.), Ristevski et al. (2018, ds 2, ch. 3); Smith et al. (in review, ds 1, ch.3); Ősi et al. (2018, ds 1, ch. 7).* *State (0) does not imply the platyrostral condition, although that is the most likely morphology.* *State (1) does not imply the rostrum will be tubular, although a tubular rostrum is most likely (1) in proportion.* *State (2) does not imply the oreinirostral condition, although that is the most likely morphology.* 0. wider than high (lateromedial axis greater than dorsoventral axis, by more than 10%) 1. height and width subequal (lateromedial & dorsoventral axes subequal ±10%) 2. higher than wide (dorsoventral axis greater than lateromedial axis, by more than 10%)
8	**Rostrum, in dorsal view – amblygnathy ("bullet-shaped", with the rostrum retaining its width along almost all its length):** *Young et al. (2012, ch. 3); Young (2014, ch. 3); Young et al. (2016, ds 2, ch. 3), Ristevski et al. (2018, ds 2, ch. 4); Smith et al. (in review, ds 1, ch.4); Ősi et al. (2018, ds 1, ch. 8).* *State (1) is a putative apomorphy of* Dakosaurus + *Mr Leeds' dakosaur.* 0. no 1. yes
9	**Rostrum, presence of distinct flattening of the cranial rostrum dorsal surface and symphyseal dentary ventral surface:** *Smith et al. (in review, ds 1, ch. 5); Ősi et al. (2018, ds 1, ch. 9).* *State (1) occurs in* Sarcosuchus *and* Chalawan. *This character can be scored based on either the cranial or mandibular rostrum.* *This character scores the almost planar dentary symphyseal region, and the flattening of the cranial rostrum. Note, this character does not score for the 'duck'-billed morphology seen in some crocodylomorphs, only the flattening seen in the giant pholidosaurids.* 0. no 1. yes
10	**Rostrum narrows markedly in dorsal view, immediately in front of the orbits** *Young et al. (2016, ds 2, ch. 4), Ristevski et al. (2018, ds 2, ch. 5); Smith et al. (in review, ds 1, ch. 6); Ősi et al. (20182, ds 1, ch. 10).* *In Thalattosuchia, state (1) occurs in* Aeolodon priscus, Mycterosuchus nasutus, Bathysuchus megarhinus *and* Teleosaurus cadomensis. *Note that in many* Steneosaurus bollensis *specimens the dorsoventral compression of the skulls exaggerates the width of the temporal region.* 0. no 1. yes

Craniomandibular ornamentation (Ch. 11 – 16; 1.304% of characters)

#	Description
11	**Ornamentation (maxilla in dorsal view = external surface):** *Young & Andrade (2009, ch. 84 mod.); Young et al. (2011, ch. 84 mod.); Young et al. (2013a, ch. 2 mod.); Young et al. (2012, ch. 4 mod.); Young (2014, ch. 4); Young et al. (2016, ds 2, ch. 5), Ristevski et al. (2018, ds 2, ch. 7); Smith et al. (in review, ds 1, ch. 8); Ősi et al. (2018, ds 1, ch. 11).* 0. no conspicuous ornamentation, or ornamented with an irregular pattern of ridges, rugosities and anastomosing grooves 1. conspicuous circular-to-polygonally pitted pattern 2. conspicuous grooved-ridged pattern 3. conspicuous pits and grooves
12	**Ornamentation (frontal):** *Young (2006, ch. 1 mod.); Wilkinson et al. (2008, ch. 1 mod.); Young & Andrade (2009, ch. 1 mod.); Young et al. (2011, ch. 1 mod.); Young et al. (2013a, ch. 46 mod.); Young et al. (2012, ch. 55 mod.); Young (2014, ch. 57); Young et al. (2016, ds 2, ch. 65), Ristevski et al. (2018, ds 2, ch. 8); Smith et al. (in review, ds 1, ch. 9); Ősi et al. (2018, ds 1, ch. 12).* *In metriorhynchids, the main body of the frontal can be largely or entirely 'smooth', while the anteromedial process is ornamented. If this process is ornamented, the taxon was still scored from states (0–2).* 0. yes, with shallow to deep elliptical pits and shallow to deep grooves 1. yes, shallow to deep elliptical pits 2. yes, shallow to deep grooves 3. no
13	**Ornamentation (dorsal surface of the medial temporal region, typically the intertemporal bar):** *Jouve et al. (2005b, ch. 30 mod.); Jouve et al. (2008, ch. 30 mod.); Hastings et al. (2010, ch. 8 mod.), Ristevski et al. (2018, ds 2, ch. 9 mod.); Smith et al. (in review, ds 1, ch. 10 mod.); Ősi et al. (2018, ds 1, ch. 13).* *Note, herein we have re-worded this character to score for ornamentation along the dorsal surface of the medial temporal region, and not the intertemporal bar. This allows taxa that lack supratemporal fenestrae (such as* Iharkutosuchus*) to be scored for this character.* 0. ornamented 1. unornamented
14	**Ornamentation (parietal in dorsal view):** *Jouve et al. (2005b, ch. 27 mod.); Jouve et al. (2008, ch. 27 mod.); Hastings et al. (2010, ch. 45 mod.), Ristevski et al. (2018, ds 2, ch. 10); Smith et al. (in review, ds 1, ch. 11); Ősi et al. (2018, ds 1, ch. 14).* 0. no conspicuous ornamentation 1. slight ornamentation 2. strongly ornamented with deep and/or numerous pits
15	**Sculpturing, palatal surface of maxilla:** *Ortega et al. (2000, ch. 2); Andrade et al. (2011, ch. 20); Ristevski et al. (2018, ds 1, ch. 20); Smith et al. (in review, ds 2, ch. 20); Ősi et al. (2018, ds 1, ch. 15).* *State (1) was also registered for* Sichuanosuchus*,* Shantungosuchus *and* Fruitachampsa *by Ortega et al. (2000), but the absence (0) in* Hemiprotosuchus *cannot be confirmed, as the specimen is preserved with mandible in occlusion. Palatal sculpturing is also present in a few notosuchians.* 0. absent, palatal surface smooth 1. present, palatal surface ornamented with ridges
16	**Sculpturing, presence on the palatal surface of pterygoid:** *Clark (1994, ch. 40); Andrade et al. (2011, ch. 21); Ristevski et al. (2018, ds 1, ch. 21); Smith et al. (in review, ds 2, ch. 21); Ősi et al. (2018, ds 1, ch. 16).* *State (1) is present in Protosuchidae.* 0. absent, surface smooth 1. present

Internal neuroanatomy, sensory systems and cranial exocrine glands

(Ch. 17 – 19; 0.652% of characters)

[Scoring any OTU for these characters can come from: CT scan datasets or specimens with the cranium broken showing said cavity. All characters in this

section refer to internal anatomy, principally internal cavities and structures. Thus are not included in the sections referring to bones visible externally]

#	Description
17	**Enlarged paired blood vessels extending into and from the pituitary gland, presence: (NEW)** *In thalattosuchians (such as* Steneosaurus gracilirostris, Pelagosaurus typus*) the cerebral carotid and orbital arteries are hypertrophied.* *State (1) is a putative apomorphy of Thalattosuchia.* 0. absent, the cerebral carotid and orbital arteries are not enlarged 1. present, these vessels are noticeably enlarged (= hypertrophied)
18	**Enlarged paired dural venous sinus system dorsal to the hindbrain, presence: (NEW)** *In thalattosuchians (such as* Steneosaurus gracilirostris, Pelagosaurus typus, Cricosaurus araucanensis*) the posterior branch of the transverse dural venous sinus (= posterior middle cerebral vein) is hypertrophied.* *State (1) is a putative apomorphy of Thalattosuchia.* 0. absent, dural venous system system is not enlarged 1. present, these sinuses are noticeably enlarged (= hypertrophied)
19	**Internal enlarged cephalic exocrine glands, presence:** *Andrade et al. (2011, ch. 485 mod.); Ristevski et al. (2018, ds 2, ch. 386 mod.); Smith et al. (in review, ds 1, ch. 392 mod.); Ősi et al. (2018, ds 1, ch. 453).* *The evidence for internal large cephalic exocrine glands is well supported (e.g. Fernández & Gasparini, 2000, 2008; Gandola et al., 2006; Fernández & Herrera, 2009), and interpreted as structures for salt excretion. In fossil specimens, lobulations for glands must show a regular pattern, and have no trabecular bones, which otherwise indicate the presence of pneumatic cells of air sinuses (Fernández & Herrera, 2009).* *Note that in metriorhynchids the chambers housing these enlarged glands indicate their presence.* *These enlarged nasal glands are also associated with gland drainage ducts.* *State (1) occurs in Metriorhynchidae.* 0. absent, nasal glands not enlarged 1. present, nasal glands enlarged (= hypertrophied), being bound externally by the nasal, prefrontal, lachrymal, maxilla and jugal

Craniomandibular pneumaticity (Ch. 20 – 23; 0.870% of characters)
[Scoring any OTU for these characters can come from: CT scan datasets or specimens with the cranium broken showing said cavity. All characters in this section refer to internal pneumatic cavities or the enclosure of pneumatic structures by bone. Thus are not included in the sections referring to bones visible externally]

#	Description
20	**Supraoccipital, internal presence of the cavity for the intertympantic diverticulum of the pharyngotympanic sinus system (= the "mastoid antrum"):** *Clark (1994, ch. 63 mod.); Andrade et al. (2011, ch. 282 mod.); Ristevski et al. (2018, ds 2, ch. 165); Smith et al. (in review, ds 1, ch. 169); Ősi et al. (2018, ds 1, ch. 186).* *As discussed by Wilberg (2015b), this character has been scored to unite Pholidosauridae and Dyrosauridae with Thalattosuchia. The natural external and internal mould* Pholidosaurus schaumburgensis *Bückeburg specimens held in Berlin show the cavity for this diverticulum (also see Wilberg, 2015b Figure 7c).* *Scoring any OTU as state (1) can come from CT scan datasets, or fossil specimens with a broken supraoccipital that show the cavity. However, scoring an OTU can only reliably come from CT scan datasets, or acid prepared specimens that have the braincase preserved. While this limits the number of OTUs that can be scored, it helps prevent potential mis-scorings. Here* Dyrosaurus*,* Sarcosuchus *and* Terminonaris *are scored as (?) until CT scans conclusively show the lack of this diverticulum.* *State (0) occurs in Thalattosuchia.*

	0. absent (in Thalattosuchia this diverticulum is absent) 1. present
21	**Quadrate, openings on the dorsal surface at the proximal end (= subtympanic foramina; = quadrate fenestrae):** *Young & Andrade (2009, ch. 158 mod.); Young et al. (2011, ch. 158 mod.); Young et al. (2013a, ch. 104 mod.); Young et al. (2012, ch. 121 mod.); Young (2014, ch. 124 mod.); Young et al. (2016, ds 2, ch. 145 mod.); Ristevski et al. (2018, ds 2, ch. 198); Smith et al. (in review, ds 1, ch. 202); Ősi et al. (2018, ds 1, ch. 220).* *This character scores the presence of foramina on the proximal quadrate for the infundibular diverticula of the pharyngotympanic sinus system contacting the tympanum.* *State (2) occurs in Thalattosuchia.* 0. multiple subtympanic foramina 1. single subtympanic foramen 2. lacks subtympanic foramina
22	**Quadrate (and articular), foramina aërum presence:** *Ristevski et al. (2018, ds 2, ch. 199); Smith et al. (in review, ds 1, ch. 203); Ősi et al. (2018, ds 1, ch. 221).* *This character scores the presences of the aërum foramina on the dorsal or mediodorsal surface of the distal quadrate, and the associated opening on the dorsal or medial surface of the retroarticular process of the mandible. These foramina are for the siphonium connecting the quadrate and articular diverticula of the pharyngotympanic sinus system.* *Note that in large adults the articular diverticula can completely regress, thus the quadrate aërum foramen may be the best indicator of the structure's presence.* *Following Nesbitt (2011; discussion on ch. 159), basal crocodylomorphs (i.e. 'sphenosuchians') the large medial articular foramina are not considered to be articular aërum foramina. Whether basal crocodylomorphs had articular diverticula is currently unknown.* *State (0) occurs in Thalattosuchia (basal crocodylomorphs are scored as '?').* *State (1) is currently only known to occur in Crocodyliformes.* 0. absent 1. present
23	**Median pharyngeal and pharyngotympanic tubes (= "Eustachian tubes"), relation to basioccipital and basisphenoid: (ORDERED)** *Clark (1994, ch. 52 mod.); Andrade et al. (2011, ch. 290 mod.); Nesbitt (2011, ch. 121 – based on Gower 2002, ch. 13); Young et al. (2013a, ch. 108); Young et al. (2012, ch. 126); Young (2014, ch. 130); Young et al. (2016, ds 2, ch. 152); Ristevski et al. (2018, ds 2, ch. 206); Smith et al. (in review, ds 1, ch. 210); Ősi et al. (2018, ds 1, ch. 228)*. *State (1) occurs in* Postosuchus *and 'sphenosuchians'.* *State (2) occurs in Crocodyliformes.* 0. not enclosed by bone 1. partially enclosed between the basioccipital and basisphenoid 2. entirely enclosed between the basioccipital and basisphenoid

Rostral neurovascular foramina (Ch. 24 – 29; 1.304% of characters)

#	Description
24	**Neurovascular foramina, presence of an expanded network of openings on the dorsal surface of the rostrum and ventral-lateral surfaces of the mandible:** *Andrade et al. (2011, ch. 22), Ristevski et al. (2018, ds 2, ch. 11); Smith et al. (in review, ds 1, ch. 12); Ősi et al. (2018, ds 1, ch. 17).* *Based on the data by Soares (2002), where neurovascular foramina are related to the presence of dome pressure receptors (DPR).* *Three groups of teleosauroids score as state (1) – Machimosaurini,* Steneosaurus brevior*, and* Mycterosuchus nasutus*. Some other species of teleosauroids have the anterior tip of the dentary covered in numerous foramina, even though they have only the basal single line of foramina on the maxillae. In all thalattosuchians the dentary foramina are greater in number, and are easier to observe. In teleosauroids with no/little premaxillary/maxillary ornamentation, the accessory foramina are visible on the premaxilla and on the anterior maxillae. In Machimosaurini these foramina are much more numerous, and therefore easier to identify.* *Metriorhynchids however clearly have accessory foramina on the premaxillae, maxillae and dentaries, although they do not have the 'beehive-like' arrangement mentioned for extant taxa. The maxillary foramina can be observed across the element, and are not restricted to the*

	anterior maxilla as in teleosauroids. Pelagosaurus typus *has clear accessory foramina on the anterior dentaries, and perhaps has some on the premaxilla so it is here scored as (0).* *It is unclear whether the thalattosuchian condition is homologous to that seen in neosuchians (or whether it evolved multiple times within Thalattosuchia).* *This character might need to be re-evaluated, as George & Holliday (2013) have questioned the utility of using facial neurovascular foramina as osteological correlates for the DPR system.* 0. absent, neurovascular openings limited to a single line, near the ventral margin of the rostrum and dorsal margin of dentary 1. present at least at the premaxillae, maxillae and dentaries
25	**Neurovascular foramina (premaxilla), overall distance to the alveolar margin and teeth:** *Andrade & Bertini (2008, ch. 17 part); Andrade et al. (2011, ch. 23); Ristevski et al. (2018, ds 1, ch. 23); Smith et al. (in review, ds 2, ch. 23); Ősi et al. (2018, ds 1, ch. 18).* *Note that Andrade et al. (2011) substantially re-scored this character from the original (Andrade & Bertini 2008, ch17), and that complementary characters on neurovascular foramina are present.* 0. ventral-most foramina reach area next to the alveolar margin, close to teeth 1. ventral-most foramina clearly apart from the alveolar margin, distant to the teeth
26	**Neurovascular foramina (anterior maxilla), overall distance to the alveolar margin and teeth:** *Andrade & Bertini (2008, ch. 17 part); Andrade et al. (2011, ch. 24); Ristevski et al. (2018, ds 1, ch. 24); Smith et al. (in review, ds 2, ch. 24); Ősi et al. (2018, ds 1, ch. 19).* *State (0) is putative apomorphy of derived eusuchians, but is also present in other mesoeucrocodylian clades.* *State (1) is a common condition in Crocodylomorpha, occurring even in basal eusuchians.* 0. ventral-most foramina reach area next to the alveolar margin, close to teeth 1. ventral-most foramina clearly apart from the alveolar margin, distant to the teeth
27	**Neurovascular foramina (mid maxilla) forming a strongly arched line at mid-rostrum, at maturity:** *Andrade et al. (2011, ch. 25); Ristevski et al. (2018, ds 1, ch. 25); Smith et al. (in review, ds 2, ch. 25); Ősi et al. (2018, ds 1, ch. 20).* *State (1) is putative apomorphy of* Araripesuchus. 0. absent, line of foramina follows the overall outline of the margin 1. present, ample area of smooth margin ventral to the arched line of foramina
28	**Neurovascular foramina (posterior maxilla), distribution on the alveolar margin:** *Andrade et al. (2011, ch. 26); Young et al. (2016, ds 2, ch. 26), Ristevski et al. (2018, ds 2, ch. 12); Smith et al. (in review, ds 1, ch. 13); Ősi et al. (2018, ds 1, ch. 21).* *State (1) occurs in goniopholidids.* 0. ventral-most foramina not high on the maxillary margin, either close or next to the alveoli 1. ventral-most foramina high on the maxilla (up to twice the distance from other foramina), very distant to the alveoli
29	**Neurovascular foramina (dentary), distribution of neurovascular foramina relative to the alveolar margin, in non-tubular snouted forms: (*)** *Andrade et al. (2011, ch. 27); Ristevski et al. (2018, ds 1, ch. 27); Smith et al. (in review, ds 2, ch. 27); Ősi et al. (2018, ds 1, ch. 22).* *This character is not applicable for taxa that have tubular snouts.* *State (1) occurs in Crocodylia.* 0. foramina form a simple straight to ventrally-arched line 1. foramina form a sinusoid line, following the dorsal fluttings, when fluttings are present

Cranial rostrum (Ch. 30 – 87; 12.609% of characters)

[external nares, dermatocranial bones (= os præmaxillare, ossa nasalia, os maxillare and ossa lacrimalia), antorbital cavity]

#	Description
30	**Perinarial crests, presence and morphology:** *Andrade et al. (2011, ch. 29); Ristevski et al. (2018, ds 1, ch. 29); Smith et al. (in review, ds 2, ch. 29); Ősi et al. (2018, ds 1, ch. 23).* *State (1) is present within Goniopholididae (*Anteophthalmosuchus, Hulkeopholis, Goniopholis *and* Amphicotylus*).* 0. absent, surface even or bearing a perinarial fossa

	1. present as well defined and distinct ridges, cornering the lateral to posterior borders of the naris
31	**External nares orientation:** *Turner & Pritchard (2015, ch. 6; modified from Clark 1994, ch. 6); Young et al. (2016, ds 2, ch. 8), Ristevski et al. (2018, ds 2, ch. 14); Smith et al. (in review, ds 1, ch. 15); Ősi et al. (2018, ds 1, ch. 24).* *In Thalattosuchia, state (0) occurs in the teleosauroids* Mycterosuchus nasutus, *the Chinese teleosauroid referred to* Peipehsuchus teleorhinus*,* Platysuchus multiscrobiculatus*,* Steneosaurus brevior *and* Teleosaurus megarhinus. 0. orientated anteriorly, anterodorsally, or anterolaterally 1. orientated mainly dorsally, or dorsolaterally
32	**External nares, shape in dorsal view:** *Young (2006, ch. 6 mod.); Wilkinson et al. (2008, ch. 23 mod.); Young & Andrade (2009, ch. 23 mod.); Young et al. (2011, ch. 23 mod.); Young et al. (2013a, ch. 4 mod.); Young et al. (2012, ch. 6 mod.); Young (2014, ch. 6 mod.); Young et al. (2016, ds 2, ch. 9), Ristevski et al. (2018, ds 2, ch. 15); Smith et al. (in review, ds 1, ch. 16); Ősi et al. (2018, ds 1, ch. 25).* *State (4) is a putative apomorphy of Susisuchidae.* 0. subcircular (diameter in any direction does not vary by more than ± 10%) 1. oval (dorsal width is greater than 10% longer than anteroposterior length) 2. 'D-shaped', with posterior edge straight 3. spoon-shaped elongate ellipse (dorsal width is less than 40% of anteroposterior length) 4. pear-shaped 5. external nares not exposed in dorsal view
33	**External nares, shape in anterior view:** *Foffa et al. (in review, ch. 31)* *State (1) occurs in* Aeolodon priscus*,* Bathysuchus megarhinus*,* Steneosaurus brevior*, and the Chinese teleosauroid.* 0. subcircular or 'B-shaped' (the anterior margin is relatively straight) 1. noticabely '8-shaped'
34	**Medial tubercles of external nares on the posterior margin:** *Hastings et al. (2010, ch. 2 mod.), Ristevski et al. (2018, ds 2, ch. 16); Smith et al. (in review, ds 1, ch. 17); Ősi et al. (2018, ds 1, ch. 26).* *States (1+2) are putative apomorphies of Dyrosauridae.* 0. absent 1. dorsal 2. ventral
35	**Thickness of the anterior margin of the external nares: (*)** *Hastings et al. (2010, ch. 3 mod.), Ristevski et al. (2018, ds 2, ch. 17); Smith et al. (in review, ds 1, ch. 18); Ősi et al. (2018, ds 1, ch. 27).* *State (1) occurs in basal dyrosaurids.* *This character is not applicable for taxa that have posterodorsally retracted external nares (i.e. rhacheosaurin metriorhynchids).* 0. less than half anteroposterior length 1. greater than half anteroposterior length, or in species with a broad snout the anterior premaxilla is noticeably thick with the external nares posterior to the P1 alveoli
36	**External nares, posterodorsal retraction in relation to the tooth-row: (ORDERED)** *Young (2006, ch. 16 mod.); Wilkinson et al. (2008, ch. 38 mod.); Young & Andrade (2009, ch. 38 mod.); Young et al. (2011, ch. 38 mod.); Young et al. (2013a, ch. 5 mod.); Young et al. (2012, ch. 7 mod.); Young (2014, ch. 7 mod.); Young et al. (2016, ds 2, ch. 10), Ristevski et al. (2018, ds 2, ch. 18); Smith et al. (in review, ds1, ch. 19); Ősi et al. (2018, ds 1, ch. 28).* *This character was designed to quantify the degree of posterodorsal retraction of the external nares in Metriorhynchidae. Its level relative to the tooth-row is used in this regard.* *Previous states (4–6) of this character were removed by Young et al. (2016) as the maxillary tooth count is too variable.* 0. at the tip of the snout, with its posterior-margin not exceeding the first premaxillary alveolus 1. at the tip of the snout, but its posterior-margin does exceed the last premaxillary alveolus 2. the posterior-margin reaches to the beginning of the 1st maxillary alveolus 3. posterodorsally displaced, anterior-margin begins posterior to the 1st premaxillary alveolus while the posterior-margin exceeds the beginning of the 1st maxillary alveolus
37	**Postnarial fossa, presence:**

	Andrade et al. (2011, ch. 41); Ristevski et al. (2018, ds 1, ch. 41); Smith et al. (in review, ds 2, ch. 41); Ősi et al. (2018, ds 2, ch. 42). *State (1) is putative apomorphy of derived goniopholidids, but still poorly sampled in Neosuchia.* 0. absent 1. present
38	**Intranarial fossa, presence at the lateral walls, inside narial cavity, at the vestibulum:** *Andrade et al. (2011, ch. 42), Ristevski et al. (2018, ds 2, ch. 20); Smith et al. (in review, ds 1, ch. 21); Ősi et al. (2018, ds 1, ch. 30).* *State (1) is putative apomorphy of Thalattosuchia.* *The internarial fossa is an additional chamber that creates an internal border of the external naris; must not be mistaken with the naso-oral fossa, or with the perinarial fossa.* *Note, unlike Andrade et al. (2011), we consider this to present in all thalattosuchians. A distinct fossa within the nasal cavity is seen in all teleosauroids and* Pelagosaurus typus*, however due to dorsoventral crushing the fossa can be obscured.* 0. absent 1. present
39	**Premaxilla, dorsal/anterodorsal projection of the anterodorsal margin (anterior to the external nares):** *Young et al. (2016, ds 2, ch. 11), Ristevski et al. (2018, ds 2, ch. 21); Smith et al. (in review, ds 1, ch. 22); Ősi et al. (2018, ds 1, ch. 31).* *State (1) occurs in derived pholidosaurids*, *as well as in eusuchians.* 0. present 1. absent
40	**Premaxilla, lateral expansion anterior to the premaxilla-maxilla suture due to the enlargement of the P3 alveoli, with a constriction immediately posterior to the expansion:** *Hastings et al. (2010, ch. 14 mod.), Ristevski et al. (2018, ds 2, ch. 22); Smith et al. (in review, ds 1, ch. 23); Ősi et al. (2018, ds 1, ch. 33).* *State (1) occurs in basal dyrosaurids.* *Note that unlike other lateral expansions of the premaxilla, this does not correlate with a lateral expansion of the dentary.* 0. absent 1. present
41	**Premaxilla, length compared to width: (*)** *Jouve et al. (2008, ch. 41 mod.); Hastings et al. (2010, ch. 22 mod.), Ristevski et al. (2018, ds 2, ch. 23); Smith et al. (in review, ds 1, ch. 24); Ősi et al. (2018, ds 1, ch. 34).* *State (1) occurs in derived dyrosaurids.* *This character is not applicable for taxa that have posterodorsally retracted external nares.* 0. slightly longer than wide 1. nearly three times longer than wide, or more than three times longer than wide
42	**Premaxilla, ventral surface, presence of large depressions/notches for reception of the D1 teeth:** *Ristevski et al. (2018, ds 2, ch. 24); Smith et al. (in review, ds 1, ch. 25); Ősi et al. (2018, ds 1, ch. 35).* *State (1) occurs in the pholidosaurids* Terminonaris, Meridiosaurus, Sarcosuchus *and* Oceanosuchus, *goniopholididids* Anteophthalmosuchus sp., Amphicotylus stovalli *and* Calsoyasuchus, *and basal dyrosaurids* (e.g. Cerrejonisuchus). *State (2) occurs in* Elosuchus cherifiensis *and* E. broinae. 0. absent 1. occurs posterior to either the P1–P2 (or just the P2) alveoli, and are ventral to the external nares 2. occurs between, and separates, the P1–P2 alveoli from the P3–P4 alveoli
43	**Premaxilla, when seen in lateral view: (ORDERED)** *Young et al. (2016, ds 2, ch. 13 mod.), Ristevski et al. (2018, ds 2, ch. 26); Smith et al. (in review, ds 1, ch. 27); Ősi et al. (2018, ds 1, ch. 36).* *This character scores the 'pholidosaurid beak'. However,* Meridiosaurus *does not have a fully sub-vertical 'beak', but do have an intermediate morphology. This morphology is herein considered homologous to the ventral alveolar row of goniopholidids and basal dyrosaurids.* *State (1) occurs in* Meridiosaurus, Elosuchus, *and the French* Pholidosaurus, *and in the goniopholidids* Anteophthalmosuchus sp., Amphicotylus stovalli *and* Goniopholis kiplingi, *and the basal dyrosaurid* Cerrejonisuchus.

	State (2) occurs in the pholidosaurids Chalawan, Sarcosuchus, Terminonaris *and* Oceanosuchus, 0. the anterior and anterolateral margins are not sub-vertical, and do not extend ventrally when compared to the rest of the premaxilla (i.e. the dentigerous margins) 1. the anterior and anterolateral margins are slightly sub-vertical, and slightly extend ventrally to the rest of the element 2. the anterior and anterolateral margins are fully sub-vertical and extend ventrally to the rest of the element
44	**Premaxilla, when seen in lateral view:** *Ristevski et al. (2018, ds 2, ch. 27); Smith et al. (in review, ds 1, ch. 28); Ősi et al. (2018, ds 1, ch. 37).* *State (1) occurs in the teleosauroids* Mycterosuchus nasutus, *the Chinese teleosauroid referred to* Peipehsuchus teleorhinus*,* Platysuchus multiscrobiculatus*,* Steneosaurus brevior *and* Bathysuchus megarhinus. *This character is not homologous to the pholidosaurid ventral verticalisation of the premaxilla, as in this sub-set of teleosauroids the premaxilla is strongly orientated anteroventrally in lateral view.* 0. the anterior and anterolateral margins are either not sub-vertical, or do not extend ventrally when compared to the rest of the premaxilla (i.e. the dentigerous margins) 1. the anterior and anterolateral margins are orientated anteroventrally and extend ventrally to the rest of the element.
45	**Premaxilla, proportion of total length posterior to the external nares:** *Wilkinson et al. (2008, ch. 21); Young & Andrade (2009, ch. 21); Young et al. (2011, ch. 21); Young et al. (2013a, ch. 6); Young et al. (2012, ch. 8); Young (2014, ch. 8); Young et al. (2016, ds 2, ch. 14) Ristevski et al. (2018, ds 2, ch. 28); Smith et al. (in review, ds 1, ch. 29); Ősi et al. (2018, ds 1, ch. 38).* 0. greater than 67% of premaxilla total length is posterior to the external nares 1. between 50–65% 2. between 36–45% 3. 28% or less
46	**Premaxilla, posterodorsal (= maxillary, = subnarial) process, termination:** *Nesbitt & Desojo (2017, ch. 415); Ősi et al. (2018, ds 1, ch. 39).* *State (1) occurs in Crocodylomorpha.* 0. anterior to or at the posterior end of the external naris 1. posterior of the posterior extension of the external naris
47	**Premaxilla, posterodorsal process: (*)** *Young (2014, ch. 9); Young et al. (2016, ds 2, ch. 15); Ristevski et al. (2018, ds 2, ch. 29); Smith et al. (in review, ds 1, ch. 30); Ősi et al. (2018, ds 1, ch. 40).* *State (1) occurs in* Tyrannoneustes lythrodectikos, Torvoneustes, 'Metriorhynchus' hastifer *and Mr Passmore's specimen.* *This character is not applicable for taxa that retract their external nares (i.e. rhacheosaurin metriorhynchids).* 0. short, terminates level to the fourth maxillary alveolus, or more anteriorly 1. long, terminates level to the end of the fourth maxillary alveolus, or more posteriorly
48	**Premaxilla, development of premaxillary septum:** *Young (2006, ch. 7 mod.); Wilkinson et al. (2008, ch. 24 mod.); Young & Andrade (2009, ch. 24 mod.); Young et al. (2011, ch. 24 mod.); Young et al. (2013a, ch. 7); Young et al. (2012, ch. 9); Young (2014, ch. 10); Young et al. (2016, ds 2, ch. 16); Ristevski et al. (2018, ds 2, ch. 30); Smith et al. (in review, ds 1, ch. 31); Ősi et al. (2018, ds 1, ch. 41).* *State (1) scores the premaxillary septum of Metriorhynchidae.* *Terminonaris currently scored as '?', as it is unclear whether there was also a separating septum present.* *Young et al. (2013a) changed this character from a multi-state to its present binary form. Currently, only Rhacheosaurini metriorhynchids are definitively known to have had a full premaxillary septum, however specimens of* Metriorhynchus superciliosus*, 'M.'* brachyrhynchus, *Mr Passmore's specimen and* Tyrannoneustes lythrodectikos *have preserved: the proximal end of the bar, and the raised distal articulation region on the premaxilla associated with the anterior end of the bar in Rhacheosaurini.Thus, they have been scored as (1). It is possible that only Rhacheosaurini has a fully ossified premaxillary bar, or the incomplete bar could be due to post-mortem damage.*

	It is not homologous with other crocodylomorph septa, which are either partially formed by the nasals, or do not originate on the external surface of the premaxilla immediately anterior to the nasal fossa. 0. no septum, with a single undivided external naris, or a divided external naris not formed solely by a premaxillary septum 1. external nares dorsally divided by a midline premaxillary septum
49	**Rostrum, morphology of the external surface of premaxilla and maxilla:** *based on Pol (1999, ch. 153); Andrade et al. (2011, ch. 55); Ristevski et al. (2018, ds 2, ch. 31); Smith et al. (in review, ds 1, ch. 32); Ősi et al. (2018, ds 1, ch. 42).* *State (1) is putative apomorphy of Notosuchidae + Sphagesauridae.* *Most commonly in state (1), the ventral plane will face laterally and slightly ventrally; the dorsal plane will face laterodorsally.* 0. rostrum with a continuous surface, either convex or plain 1. rostrum with distinct ventral and dorsal surfaces, plain and separated by a somewhat distinct anteroposterior ridge or edge
50	**Rostrum, type of contriction at the premaxilla-maxilla suture:** *Clark (1994, ch. 9 mod.); Wilkinson et al. (2008, ch. 20 mod.); Young & Andrade (2009, ch. 20 mod.); Andrade et al. (2011, ch. 57); Young et al. (2011, ch. 20 mod.); Young et al. (2013a, ch. 75 mod.); Young et al. (2012, ch. 88 mod.); Young (2014, ch. 90 mod.); Young et al. (2016, ds 2, ch. 108 mod.); Ristevski et al. (2018, ds 2, ch. 32); Smith et al. (in review, ds 1, ch. 33); Ősi et al. (2018, ds 1, ch. 43).* *State (0) is a putative apomorphy of* Araripesuchus*.* *The vast majority of crocodylomorphs can be considered as (1), but highly predaceous forms will show a well-defined notch at the premaxilla-maxilla suture (2).* 0. narrow slit 1. wide, poorly-defined concavity, or not constricted at all 2. well-defined notch
51	**Premaxillae anterior to naris, morphology:** *Clark (1995, ch. 5 mod.); Andrade et al. (2011, ch. 62); Ristevski et al. (2018, ds 2, ch. 33); Smith et al. (in review, ds 1, ch. 34); Ősi et al. (2018, ds 1, ch. 44).* *State (0) is putative apomorphy of Notosuchidae + Sphagesauridae.* *State (1) is a putative apomorphy of* Araripesuchus + Libycosuchus*.* 0. anterior rami of premaxillae do not meet medially, anterior/ventral to naris, with both premaxillae in contact only through palatine rami 1. anterior rami of premaxillae meet anterior to naris, through a very narrow band, but not projecting vertically 2. anterior rami of premaxillae broadly meet anterior to naris, forming a vertical wall, which may be straight or slightly convex
52	**Premaxilla, type of contact with maxilla:** *Clark (1994, ch. 8); Andrade et al. (2011, ch. 63); Ristevski et al. (2018, ds 2, ch. 34); Smith et al. (in review, ds 1, ch. 35); Ősi et al. (2018, ds 1, ch. 45).* *State (1) is a putative apomorphy of Crocodyliformes.* 0. premaxilla loosely overlies maxilla on face 1. premaxilla and maxilla suture together along butt joint
53	**Distance between premaxilla and nasal:** *Young (2006, ch. 5 mod.); Wilkinson et al. (2008, ch. 22 mod.); Young & Andrade (2009, ch. 22 mod.); Young et al. (2011, ch. 22 mod.); Young et al. (2013a, ch. 8 mod.); Young et al. (2012, ch. 10); Young (2014, ch. 11); Young et al. (2016, ds 2, ch. 17); Ristevski et al. (2018, ds 2, ch. 35); Smith et al. (in review, ds 1, ch. 36); Ősi et al. (2018, ds 1, ch. 46).* *State (2) occurs in* Meridiosaurus *and* Gavialis gangeticus. *States (1+2) are putative apomorphies of Thalattosuchia. But with reversals, some specimens of* 'Metriorhynchus' brachyrhynchus *have contact between these elements, and the posterodorsal retraction of the external nares in* 'Cricosaurus' macrospondylus *results in contact between these elements.* 0. none, premaxilla and nasal contact 1. small, less than half the midline length of the premaxilla 2. large, approximately 80% to more than 100% of the midline length of the premaxilla
54	**Nasal contribution to the margin of the external nares:** *Young et al. (2012, ch. 11); Young (2014, ch. 12); Young et al. (2016, ds 2, ch. 18); Ristevski et al. (2018, ds 2, ch. 36); Smith et al. (in review, ds 1, ch. 37); Ősi et al. (2018, ds 1, ch. 47).* 0. present

	1. absent
55	**Anterior process of the nasals, anterior margin relative to the first maxillary alveoli: (*)** *Jouve et al. (2008, ch. 42 mod.); Hastings et al. (2010, ch. 33 mod.); Ristevski et al. (2018, ds 2, ch. 37); Smith et al. (in review, ds 1, ch. 38); Ősi et al. (2018, ds 1, ch. 48).* *State (0) occurs in pholidosaurids and derived dyrosaurids.* *Note that this character scores the posterior-ward position of the anterior margin of the nasal anterior process, due to the elongation of the premaxillary posterior process only.* *This character is not applicable for taxa that: 1) have posterodorsally retracted external nares (e.g. Rhacheosaurini), 2) lack a midline premaxillary posterior process (e.g.* Iharkutosuchus*) or 3) have the maxillae elongated and contacting along their midline (e.g. Thalattosuchia).* 0. posterior 1. anterior
56	**Nasals, morphology in dorsal view: (ORDERED)** *Andrade & Bertini (2008a, ch. 21); Young & Andrade (2009, ch. 160 mod.); Andrade et al. (2011, ch. 73); Young et al. (2011, ch. 160 mod.); Young et al. (2013a, ch. 9 mod.); Young et al. (2012, ch. 12 mod.); Young (2014, ch. 13 mod.); Young et al. (2016, ds 2, ch. 19 mod.); Ristevski et al. (2018, ds 2, ch. 38); Smith et al. (in review, ds 1, ch. 39); Ősi et al. (2018, ds 1, ch. 49).* *State (0) is a putative apomorphy of both Thalattosuchia and Notosuchia.* *State (2) is present in* Simosuchus*.* 0. triangular, lateral margins strongly confluent anteriorly 1. rectangular or subrectangular, lateral margins mostly parallel, or lateral margins poorly confluent anteriorly 2. triangular, lateral margins diverging anteriorly
57	**Nasal, lateroposterior processes:** *Young (2014, ch. 14); Young et al. (2016, ds 2, ch. 20); Ristevski et al. (2018, ds 2, ch. 39); Smith et al. (in review, ds 1, ch. 40); Ősi et al. (2018, ds 1, ch. 50).* *State (1) is a putative apomorphy of Metriorhynchidae.* *These processes suture with the anteroventral and anterior margin of the prefrontal, and the posterodorsal margin of the lachrymal.* 0. absent 1. present
58	**Nasals, fusion at maturity:** *Gasparini et al. (2006, ch. 257); Sereno & Larsson (2009, ch. 10); Hastings et al. (2010, ch. 32 mod.); Andrade et al. (2011, ch. 77); Tennant et al. (2016, ch. 65); Ristevski et al. (2018, ds 2, ch. 40); Smith et al. (in review, ds 1, ch. 41); Ősi et al. (2018, ds 1, ch. 51).* *State (1) is putative apomorphy of Dyrosauridae, but with some species having individuals with fused and unfused nasals, and some specimens with only the anterior nasals fused. Due to this variability, the character from Hastings et al. (2010) has been changed from an ordered multistate into the current binary character.* *In Thalattosuchia state (1) also occurs in* Lemmysuchus obtusidens*. As in Dyrosauridae, some individuals have fused nasals, while specimens have partially fused nasals. It is currently unclear whether the variation is ontogenetic or individual.* *State (1) is also present in Mahajangasuchidae.* 0. absent, nasals unfused 1. present, nasals at least partially fused (note that some species have variability in this character, such as in dyrosaurids)
59	**Nasals, posterior portion at the midline:** *Nesbitt (2011, ch. 34); Young et al. (2013a, ch. 10 mod.); Young et al. (2012, ch. 13 mod.); Young (2014, ch. 15 mod.); Young et al. (2016, ds 2, ch. 21); Ristevski et al. (2018, ds 2, ch. 41); Smith et al. (in review, ds 1, ch. 42); Ősi et al. (2018, ds 1, ch. 52).* *This character tests the homology of the metriorhynchoid and (most) teleosauroid "midline trench" and "depression" features, with a similar depression (state 1) seen in "rauisuchians" and "sphenosuchians".* *The morphology of* Calsoyasuchus *might be distinct, as it has two raised ridges running parallel, at either side of the midline depression, beginning on the frontal.* *Note that in some 'sphenosuchians' (i.e.* Sphenosuchus *and* Junggarsuchus*) the raised frontal ridge can continue onto the posterior nasal, and result in this depression forming around it.* 0. lacks a midline concavity or 'midline trench' - nasals are flat or convex 1. has a concavity at the midline, or a 'midline trench'
60	**Nasal contact with the prefrontal, in dorsal view: (*)**

	Young & Andrade (2009, ch. 92); Young et al. (2011, ch. 92); Young et al. (2013a, ch. 11); Young et al. (2012, ch. 14); Young (2014, ch. 16); Young et al. (2016, ds 2, ch. 22); Ristevski et al. (2018, ds 2, ch. 42); Smith et al. (in review, ds 1, ch. 43); Ősi et al. (2018, ds 1, ch. 53). *This character is not applicable for taxa that lack a sutural contact between the nasals and the prefrontals.* *State (1) is a putative apomorphy of the* Cricosaurus araucanensis. 0. irregular 1. smooth curve with a concavity directed posterolaterally
61	**Nasal-prefrontal contact:** *Young et al. (2012, ch. 15); Young (2014, ch. 17); Young et al. (2016, ds 2, ch. 23); Ristevski et al. (2018, ds 2, ch. 43); Smith et al. (in review, ds 1, ch. 44); Ősi et al. (2018, ds 1, ch. 54).* *State (1) occurs in crocodylomorphs.* 0. absent 1. present
62	**Premaxilla–maxilla lateral fossa excavating alveolus of last premaxillary tooth:** *Young & Andrade (2009, ch. 163); Young et al. (2011, ch. 163); Young et al. (2013a, ch. 12); Young et al. (2012, ch. 16); Young (2014, ch. 18); Young et al. (2016, ds 2, ch. 24); Ristevski et al. (2018, ds 2, ch. 44); Smith et al. (in review, ds 1, ch. 45); Ősi et al. (2018, ds 1, ch. 55).* 0. no 1. yes
63	**Maxilla, ventrolateral edge:** *Young & Andrade (2009, ch. 115); Young et al. (2011, ch. 115); Young et al. (2013a, ch. 13); Young et al. (2012, ch. 17); Young (2014, ch. 19); Young et al. (2016, ds 2, ch. 25); Ristevski et al. (2018, ds 2, ch. 45); Smith et al. (in review, ds 1, ch. 46); Ősi et al. (2018, ds 1, ch. 56).* 0. straight 1. single convexity 2. double convexity ('festooned')
64	**Position of the posterior-most maxillae: (ORDERED)** *Hastings et al. (2010, ch. 29 mod.); Ristevski et al. (2018, ds 2, ch. 46); Smith et al. (in review, ds 1, ch. 47); Ősi et al. (2018, ds 1, ch. 57).* *State (1+2) are putative apomorphies of Dyrosauridae.* *State (2) is a putative apomorphy of* Cerrejonisuchus. 0. anterior to, or even with, the postorbital bars 1. even with the anteroposterior midlength of the supratemporal fenestrae 2. even with, or posterior to, the posterior margins of the supratemporal fenestrae
65	**Maxilla/jugal, presence of enlarged foramina and associated fossae on the lateral margin of the posterior maxillae and/or the anterior process of the jugal. These foramina are positioned near the maxillojugal suture. These structures are anteroposteriorly aligned (note that the foramina and associated fossae are not always contiguous):** *Ristevski et al. (2018, ds 2, ch. 47); Smith et al. (in review, ds 1, ch. 48); Ősi et al. (2018, ds 1, ch. 58).* *State (1) occurs in goniopholidids and most tethysuchians (in dyrosaurids the foramen is only present on the jugal). Note that the anterior position of the 'maxillary depressions' in* Calsoyasuchus *are not consistent with this character.* 0. absent 1. present
66	**Posterior maxilla, presence of lateral fossa/fossae next to the alveolar margin, anterior to the jugal and ventral to the lachrymal:** *Young & Andrade (2009, ch. 135 mod.); Andrade et al. (2011, ch. 87 mod.); Young et al. (2011, ch. 135 mod.); Young et al. (2013a, ch. 14 mod.); Young et al. (2012, ch. 18 mod.); Young (2014, ch. 20 mod.); Young et al. (2016, ds 2, ch. 27); Ristevski et al. (2018, ds 2, ch. 48); Smith et al. (in review, ds 1, ch. 49); Ősi et al. (2018, ds 1, ch. 59).* *This character is a modification of the goniopholidid+tethysuchian enlarged foramina + associated fossae character, in which there are paired depressions on either maxilla, which are anteroposteriorly elongated, dorsoventrally high, complex and entirely supported by the maxilla.* *State (1) occurs in Goniopholididae.* *As noted for the maxilla/jugal presence of an enlarged foramina character, the anterior position of the 'maxillary depressions' in* Calsoyasuchus *are also not consistent with this character.* 0. absent, maxillary bony surface convex or flat 1. present
67	**Maxilla, morphology of anterior border of maxillary depressions:**

	Andrade et al. (2011, ch. 90); Ristevski et al. (2018, ds 2, ch. 49); Smith et al. (in review, ds 1, ch. 50); Ősi et al. (2018, ds 1, ch. 60). *State (1) is present within Goniopholididae (*Anteophthalmosuchus *and* Goniopholis*).* 0. shallow, anterior edge of depression usually poorly defined, or maxillary depression is absent 1. deep, anterior border always well-defined relative to dermal surface of maxilla
68	**Posterior maxilla, presence of a lateral fossa/fossae that crosses the maxillojugal suture:** *Young et al. (2016, ds 2, ch. 28 mod.); Ristevski et al. (2018, ds 2, ch. 50); Smith et al. (in review, ds 1, ch. 51); Ősi et al. (2018, ds 1, ch. 61).* *This character is a modification of the goniopholidid + tethysuchian enlarged foramina + associated fossae character, in which there are paired depressions on either maxilla-jugal, which are anteroposteriorly elongated, dorsoventrally narrow, and contiguous on both the maxilla and jugal.* *State (1) occurs in Pholidosauridae* 0. absent, maxillary bony surface convex or flat 1. present
69	**Maxilla, aligned set of large foramina extending posteroventrally from the antorbital/preorbital fossa:** *Young et al. (2013a, ch. 15 mod.); Young et al. (2012, ch. 19 mod.); Young (2014, ch. 21); Young et al. (2016, ds 2, ch. 29); Ristevski et al. (2018, ds 2, ch. 51); Smith et al. (in review, ds 1, ch. 52); Ősi et al. (2018, ds 1, ch. 62).* *State (1) is a putative apomorphy of Mr Leeds dakosaur* + Dakosaurus. 0. absent 1. present
70	**Maxilla-lachrymal, contact: (*)** *Pol (1999, ch. 145); Young & Andrade (2009, ch. 141); Young et al. (2011, ch. 141); Young et al. (2013a, ch. 16); Young et al. (2012, ch. 20); Young (2014, ch. 22); Young et al. (2016, ds 2, ch. 30); Ristevski et al. (2018, ds 2, ch. 52); Smith et al. (in review, ds 1, ch. 53); Ősi et al. (2018, ds 1, ch. 63).* *This character is not applicable for taxa that lack the antorbital/preorbital fossae.* 0. partially included in antorbital/preorbital fossa 1. completely included
71	**Lachrymal, contact with the nasal:** *Young & Andrade (2009, ch. 97); Young et al. (2011, ch. 97); Young et al. (2013a, ch. 17); Young et al. (2012, ch. 21); Young (2014, ch. 23); Young et al. (2016, ds 2, ch. 31); Ristevski et al. (2018, ds 2, ch. 53); Smith et al. (in review, ds 1, ch. 54); Ősi et al. (2018, ds 1, ch. 64).* 0. nasal only contacts the dorsal margin of the lachrymal 1. nasal primarily contacts the anterior margin of the lachrymal 2. no contact between the nasals and lachrymals
72	**Nasal-lachrymal suture, length compared to nasal-prefrontal suture (in dorsal view): (*)** *Young & Andrade (2009, ch. 136 mod.); Young et al. (2011, ch. 136 mod.); Young et al. (2013a, ch. 18 mod.); Young et al. (2012, ch. 22 mod.); Young (2014, ch. 24 mod.); Young et al. (2016, ds 2, ch. 32 mod.); Ristevski et al. (2018, ds 2, ch. 54); Smith et al. (in review, ds 1, ch. 55); Ősi et al. (2018, ds 1, ch. 65).* *Ristevski et al. (2018) added a new character state.* *This character is not applicable for taxa that lack the nasal-lachrymal contact.* 0. short – nasolachrymal suture is approximately 60% of the nasoprefrontal suture 1. the two sutures are sub-equal (± 25%) 2. long – nasolachrymal suture is approximately twice the length of the nasoprefrontal suture (i.e. elongation of the lachrymals)
73	**Lachrymal, dorsal exposure:** *Young (2006, ch. 13); Wilkinson et al. (2008, ch. 33); Young & Andrade (2009, ch. 33); Young et al. (2011, ch. 33); Young et al. (2013a, ch. 19); Young et al. (2012, ch. 23); Young (2014, ch. 25); Young et al. (2016, ds 2, ch. 33); Ristevski et al. (2018, ds 2, ch. 55); Smith et al. (in review, ds 1, ch. 56); Ősi et al. (2018, ds 1, ch. 66).* 0. present, can be observed in both dorsal and lateral view 1. absent, only visible in lateral view (lachrymal vertically orientated)
74	**Lachrymal, dorsal surface lateral development:** *Ristevski et al. (2018, ds 2, ch. 56); Smith et al. (in review, ds 1, ch. 57); Ősi et al. (2018, ds 1, ch. 67).* *This character scores a slight lachrymal overhang of the orbits. These structures are the anterior palpebral sutural attachements, which are medially positioned.*

	State (1) occurs in goniopholidids + tethysuchians (except dyrosaurids, Terminonaris *and* Oceanosuchus*)* 0. flush with the rim of the orbit 1. enlarged, extending laterally over the orbit
75	**Lachrymal, size:** *Young (2006, ch. 14); Wilkinson et al. (2008, ch. 34); Young & Andrade (2009, ch. 34); Young et al. (2011, ch. 34); Young et al. (2013a, ch. 20); Young et al. (2012, ch. 24); Young (2014, ch. 26); Young et al. (2016, ds 2, ch. 34); Ristevski et al. (2018, ds 2, ch. 57); Smith et al. (in review, ds 1, ch. 58); Ősi et al. (2018, ds 1, ch. 68).* 0. large, in lateral view at least 45% of orbit height 1. small, less than 40% of orbit height
76	**Antorbital cavity, presence:** *Clark (1994, ch. 67 mod.); Young & Andrade (2009, ch. 88 part); Andrade et al. (2011, ch. 43 mod.); Young et al. (2011, ch. 88 part); Young et al. (2013a, ch. 21 part); Young et al. (2012, ch. 23 part); Young (2014, ch. 27 part); Young et al. (2016, ds 2, ch. 35 part); Ristevski et al. (2018, ds 2, ch. 58 part); Smith et al. (in review, ds 1, ch. 59 part); Ősi et al. (2018, ds 1, ch. 69).* *Antorbital cavity (CA), internal and external antorbital fenestra (FAO, FAOE, FAOI) as in Witmer (1997). The antorbital cavity or the FAOE must not be confounded with the shallow fossa located directly in front of the eyes (=prefrontal-lachymal fossa sensu Young & Andrade, 2009; =lachrymal fossa sensu Andrade et al., 2011)*. *Note that here we have modified this character so that the presence of the antorbital cavity implies in the presence of a fenestra connecting the fossa with the internal antorbital sinuses (see Fernández & Herrera, 2009). We have not created a multi-state for this character with state (2) scoring for the preorbital condition, as it is unclear whether basal thalattosuchians had the antorbital fenestrae as openings for both the antorbital sinus and for the drainage duct of the hypertrophied nasal exocrine glands.* 0. absent (internalised, or the opening does not communicate with the antorbital sinus) 1. present (non-internalised, and the antorbital fenestra communicates with the antorbital sinus)
77	**Antorbital/preorbital cavity:** *Young et al. (2013a, ch. 25 mod.); Young et al. (2012, ch. 31 mod.); Young (2014, ch. 33 mod.); Young et al. (2016, ds 2, ch. 41 mod.); Ristevski et al. (2018, ds 2, ch. 64 mod.); Smith et al. (in review, ds 1, ch. 65 mod.); Ősi et al. (2018, ds 1, ch. 70).* *If hypothesis 2 of Fernández & Herrera (2009) is correct, and in metriorhynchids the antorbital cavity is internalised and the opening classically referred to as the "*antorbital fenestra*" are in fact neomorphic openings for the excretion of salt; then those taxa will score as (1) here, and (0) for the previous character on the presence/absence of the antorbital cavity.* *However, should the preorbital and antorbital fenestrae be found to be homologous, the scoring distinction currently made would still be valid. Basal metriorhynchoids which have an intermediate condition, with the openings communicating with both the antorbital sinus and for the drainage duct of the hypertrophied nasal exocrine glands would score as (1) for both characters.* *The current character construction thus does not favour one hypothesis over the other.* *The preorbital fenestra itself is typically much smaller than realised, being a small sub-circular opening at the posterior-end of the deep fossa (where the lachrymals, nasals, jugals and maxillae converge). The deep concavity in this region can sometimes be filled with matrix, making the fenestra itself appear much larger than it really is.* *Note that in Metriorhynchidae these fenestrae are set between the lachrymal, jugal and maxilla; typically, the jugal anterior ramus overlaps the maxilla externally, such that both bones contribute to the foraminal opening anteriorly. The inclusion of the nasal to the fenestra is unclear. It could be present in* Dakosaurus *and* Maledictosuchus*, but preservation in this region makes it hard to discern.* 0. absent (internalised, or the opening communicates solely with the antorbital sinus) 1. present (non-internalised, and the antorbital/preorbital fenestra communicates with the duct to the nasal exocrine gland)
78	**Antorbital cavity, relation between external and internal antorbital/preorbital fenestrae: (*)** *Andrade et al. (2011, ch. 45 mod.); Ristevski et al. (2018, ds 1, ch. 45 mod.); Smith et al. (in review, ds 2, ch. 45 mod.); Ősi et al. (2018, ds 1, ch. 71).* *State (2) is putative apomorphy of* Eoneustes *+ Metriorhynchidae.* *This character is not applicable for taxa lacking antorbital/preorbital fenestrae.* 0. external and internal fenestrae subequal or not distinguishable 1. external fenestra larger than internal fenestra, but no more than twice its area

	2. external fenestra much larger than internal fenestra, or external fenestra present and internal fenestra closed
79	**Antorbital/preorbital cavity, shape: (*)** *Young (2006, ch. 19 mod.); Wilkinson et al. (2008, ch. 41); Young & Andrade (2009, ch. 41); Andrade et al. (2011, ch. 46 mod.); Young et al. (2011, ch. 41); Young et al. (2013a, ch. 23); Young et al. (2012, ch. 28); Young et al. (2016, ch. 38); Ristevski et al. (2018, ch. 61); Smith et al. (in review, ch. 62); Ősi et al. (2018, ds 1, ch. 72).* *Note that this version of the character does not score for the elongate antorbital/preorbital cavity of metriorhynchoids. That morphological complex is scored by another character, relating to the presence of a sulcus anterior to the cavity. This means however, that any metriorhynchoid in which the cavity itself is elongated (such as as in the teleosauroid* Steneosaurus gracilirostris*) can be scored as state (1) for this character as well as for the sulcus character.* *This character is not applicable for taxa that lack antorbital fenestrae.* 0. subcircular, subtriangular or lozenge-shaped 1. anteroposteriorly elongated
80	**Antorbital/preorbital cavity, presence of a sulcus anterior to the cavity:** Gasparini *et al. (2006, ch. 246 mod.); Young (2006, ch. 19 mod. part); Wilkinson et al. (2008, ch. 41 mod. part); Young & Andrade (2009, ch. 41 mod. part); Andrade et al. (2011, ch. 46 mod. part); Young et al. (2011, ch. 41 mod. part); Young et al. (2013a, ch. 23 mod. part); Ősi et al. (2018, ds 1, ch. 73).* *State (1) is putative apomorphy of Metriorhynchoidea.* *In* Pelagosaurus typus *the sulcus is present (see Witmer, 1997), but it can be easily missed due to preservation as it is shallow when compared to the morphology seen in the clade* Eoneustes + *Metriorhynchidae*. *In well preserved specimens the distinction between the anterior sulcus and the external antorbital/preorbital fenestra is distinct (see* Dakosaurus andiniensis and Torvoneustes coryphaeus*).* *The external antorbital/preorbital fenestrae in the clade* Eoneustes + *Metriorhynchidae are bound by the jugal, lachrymal, nasal and maxilla. The anterior fossa continues anteriorly as a sulcus or fossa, but is largely present on the lateral surface of the maxilla.* *This character is not applicable for taxa lacking external antorbital/preorbital fenestrae.* 0. absent 1. present
81	**Antorbital cavity, size (area) of external antorbital/preorbital fenestra, relative to the orbit:** *Clark (1994, ch. 67 mod.); Andrade et al. (2011, ch. 47 mod.); Ősi et al. (2018, ds 1, ch. 74).* *States (0-1) occur in Crocodyliformes.* *State (2) occurs in non-crocodyliforms.* 0. small, being much smaller than the orbit area, or the antorbital cavity absent 1. moderately large, being at least half the diameter of the orbit 2. large, almost as large as the orbit
82	**Antorbital cavity, size (length) of internal antorbital/preorbital fenestra relative to the orbit:** *Clark (1994, ch. 67 mod.); Young & Andrade (2009, ch. 88 mod. part); Andrade et al. (2011, ch. 48); Young et al. (2011, ch. 88 mod. part); Young et al. (2013a, ch. 21 mod. part); Young et al. (2012, ch. 23 mod. part); Young (2014, ch. 27 mod. part); Young et al. (2016, ds 2, ch. 35 mod. part); Ristevski et al. (2018, ds 2, ch. 58 mod. part); Smith et al. (in review, ds 1, ch. 59 mod. part); Ősi et al. (2018, ds 1, ch. 75).* *States (0-1) occur in Crocodyliformes.* *State (2) occurs in* Junggarsuchus *(with reversals in some crocodyliforms, such as* Calsoyasuchus*).* *State (3) occurs in non-crocodyliforms.* 0. small, internal fenestra is less than 25% of the length of the orbit, or internal fenestra is absent 1. medium, internal fenestra is approximately 25-50% of the length of the orbit 2. large, internal fenestra is more than 50% of the length of the orbit 3. very large, internal fenestra approximately the same size as the orbit
83	**Antorbital cavity, nasal participation in the internal antorbital/preorbital fenestra: (*)** *Ortega et al. (2000, ch. 70 mod.); Wilkinson et al. (2008, ch. 40); Young & Andrade (2009, ch. 40); Andrade et al. (2011, ch. 49 mod.); Young et al. (2011, ch. 40); Young et al. (2013a, ch. 22 mod.); Young et al. (2012, ch. 29 mod.); Young (2014, ch. 31 mod.); Young et al. (2016, ds 2, ch. 39 mod.); Ristevski et al. (2018, ds 2, ch. 62 mod.); Smith et al. (in review, ds 1, ch. 63 mod.); Ősi et al. (2018, ds 1, ch. 76).*

	State (1) is a putative apomorphy of Metriorhynchidae. It also occurs in Calsoyasuchus *and* Gracilisuchus*.* *This character is not applicable for taxa lacking antorbital/preorbital fenestrae.* 0. absent, nasals excluded from the internal fenestra by a maxillo-lachrymal contact 1. present, nasals broadly reach the internal fenestra (or reach deep into the fossa, if the internal fenestra is closed or preorbital)
84	**Antorbital cavity, jugal participation in the external antorbital/preorbital fenestra: (*)** *Wu & Sues (1996, ch. 14 rev.); Clark et al. (2000, ch. 4); Ortega et al. (2000, ch. 71 rev.); Clark & Sues (2002, ch. 4); Sues et al. (2003, ch. 4); Clark et al. (2004, ch. 4);Young (2006, ch. 17); Wilkinson et al. (2008, ch. 39); Young & Andrade (2009, ch. 39); Andrade et al. (2011, ch. 50); Young et al. (2013a ch. 24 part); Young et al. (2012, ch. 30); Pol et al. (2013, ch. 4); Young (2014, ch. 32); Young et al. (2016, ds 2, ch. 40); Leardi et al. (2017, ch. 4);Ristevski et al. (2018, ds 2, ch. 63); Smith et al. (in review, ds 1, ch. 64); Ősi et al. (2018, ds 1, ch. 77).* *Should be scored alongside the characters regarding the antorbital fenestra, not jugal, to facilitate cross-checking of inapplicable states due to the absence of the antorbital fenestra.* *This character is not applicable for taxa lacking external antorbital/preorbital fenestrae.* 0. absent, jugal excluded from the external fenestra by a maxillary-lachrymal contact 1. present, jugal takes part in the external fenestra (or reach deep into the fossa, if the internal fenestra is closed or preorbital)
85	**Antorbital cavity, position relative to the rostrum: (*)** *Andrade et al. (2011, ch. 51 mod.); Ristevski et al. (2018, ds 2, ch. 66); Smith et al. (in review, ds 1, ch. 67); Ősi et al. (2018, ds 1, ch. 78).* *State (1) is putative apomorphy of Thalattosuchia.* *Ristevski et al. (2018) modified state (1) to say 'approximately equidistant…', as in some teleosauroids (*e.g. Steneosaurus brevior, Platysuchus multiscrobiculatus*) the cavity is almost equidistant between the orbits and alveolar margin. But, these taxa still have the antorbital cavity being noticeably anterior to the orbits, as with other thalattosuchians that have not closed these cavities.* *This character is not applicable for taxa lacking external antorbital/preorbital fenestrae.* 0. closer to the orbit than to the alveolar margin 1. closer to the alveolar margin than to the orbit, or approximately equidistant (but with the cavity still noticeably anterior to the orbit)
86	**Antorbital cavity, position relative to the orbit: (*)** *Andrade et al. (2011, ch. 52); Ősi et al. (2018, ds 1, ch. 79).* *This character is not applicable for taxa lacking antorbital/preorbital fenestrae.* 0. close to the orbit, with lachrymal narrow between orbit and antorbital cavity 1. distant to the orbit, with lachrymal wide between orbit and antorbital cavity
87	**Prefrontal-lachrymal fossae:** *Young & Andrade (2009, ch. 150); Young et al. (2011, ch. 150); Young et al. (2013a, ch. 27); Young et al. (2012, ch. 33); Young (2014, ch. 35); Young et al. (2016, ds 2, ch. 43); Ristevski et al. (2018, ds 2, ch. 67); Smith et al. (in review, ds 1, ch. 68); Ősi et al. (2018, ds 1, ch. 80).* *Andrade et al. (2011, ch. 30) scores for a similar character, namely the presence of a lachrymal crest anterior to the orbit.* *The prefrontal-lachrymal fossa (sensu Young & Andrade, 2009) refers to a shallow depression immediately anterior to the orbit, present on both the prefrontal and lachyrmal. It is situated posterior to the preorbital fenestra, and never contacts the preorbital fossa. There is a crest within this fossa that is present along the prefrontal-lachrymal contact (scored for by Andrade et al. 2011, ch. 30).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. absent 1. present, with ridge following the sutural contact between these elements

Skull roof (Ch. 88 – 139; 11.304% of characters)
[skull roof proportions and arrangement, supratemporal fenestrae, dermatocranial bones (= ossa præfrontalia, os frontale, ossa postorbitalia, ossa squamosal and os parietale)]

#	Description
88	**Supratemporal skull roof, dorsal surface:**

	Clark (1994, ch. 24); Young (2006, ch. 10 mod.); Wilkinson et al. (2008, ch. 29); Young & Andrade (2009, ch. 29); Andrade et al. (2011, ch. 118); Young et al. (2011, ch. 29); Young et al. (2013a, ch. 28); Young et al. (2012, ch. 34); Young (2014, ch. 36); Young et al. (2016, ds 2, ch. 44); Ristevski et al. (2018, ds 2, ch. 68); Smith et al. (in review, ds 1, ch. 69); Ősi et al. (2018, ds 1, ch. 81). *State (1) is a putative apomorphy of Crocodyliformes (reversal in Thalattosuchia).* 0. surface complex 1. flat skull table present, formed by flattened and levelled surfaces of frontal, postorbital, squamosal and parietal
89	**Posterior skull table:** *Young & Andrade (2009, ch. 99); Young et al. (2011, ch. 99); Young et al. (2013a, ch. 29); Young et al. (2012, ch. 35); Young (2014, ch. 37); Young et al. (2016, ds 2, ch. 45); Ristevski et al. (2018, ds 2, ch. 69); Smith et al. (in review, ds 1, ch. 70); Ősi et al. (2018, ds 1, ch. 82).* *Note that* Sphagesaurus *scores differently in this character, and for the preceding character.* 0. non-planar (squamosal ventral to horizontal level of postorbital and parietal) 1. planar (postorbital, squamosal, and parietal on same horizontal plane)
90	**Cranial table width relative to ventral portion of skull:** *Young & Andrade (2009, ch. 113); Young et al. (2011, ch. 113); Young et al. (2013a, ch. 30); Young et al. (2012, ch. 36); Young (2014, ch. 38); Young et al. (2016, ds 2, ch. 46); Ristevski et al. (2018, ds 2, ch. 70); Smith et al. (in review, ds 1, ch. 71); Ősi et al. (2018, ds 1, ch. 83).* 0. nearly as wide 1. narrower
91	**Supratemporal skull roof, dorsal curvature and elongation of squamosal prongs, at maturity:** *Brochu (1999, ch. 140); Young & Andrade (2009, ch. 148); Andrade et al. (2011, ch. 119); Young et al. (2011, ch. 148); Young et al. (2013a, ch. 31); Young et al. (2012, ch. 37); Young (2014, ch. 39); Young et al. (2016, ds 2, ch. 47); Ristevski et al. (2018, ds 2, ch. 71); Smith et al. (in review, ds 1, ch. 72); Ősi et al. (2018, ds 1, ch. 84).* 0. short posterolateral process of the squamosal 1. mature skull table with nearly horizontal sides; significant posterolateral process of the squamosal
92	**Supratemporal fenestrae, presence:** *Ősi et al. (2018, ds 1, ch. 85)* *State (1) occurs in Gobiosuchidae.* *State (2) is a putative autapomorphy of* Iharkutosuchus makadii. 0. present as an evident fenestra 1. presence variable during ontogeny, with the fenestrae possibly open during early ontogenetic stages (only closing later), or with there being a distinct ‘depression’ in the supratemporal region with the fenestrae themselves being reduced to a small foramen or completely closed 2. absent throughout ontogeny (i.e. supratemporal fenestrae are closed by the frontal and parietal suturing from an early ontogenetic state, with no ‘depression’ in the region)
93	**Supratemporal fossa, presence of “infratemporal flanges”: (*)** *Young & Andrade (2009, ch. 142 mod.); Nesbitt (2011, ch. 144 mod.); Young et al. (2011, ch. 142); Young et al. (2013a, ch. 36); Young et al. (2012, ch. 44 mod.); Young (2014, ch. 46 mod.); Young et al. (2016, ds 2, ch. 48); Ristevski et al. (2018, ds 2, ch. 72); Smith et al. (in review, ds 1, ch. 73); Ősi et al. (2018, ds 1, ch. 86).* *This character tests the homology of metriorhynchid "infratemporal flanges" and the teleosauroid anteromedial supratemporal fossae, with the anterior extension seen in basal crocodylomorphs.* *State (0) is a putative apomorphy of Crocodyliformes (reversal in Thalattosuchia)* *Note, this character scores for the ‘flat platform’ formed by the frontal, and not the concavity that can form in neosuchians.* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. absent anterior to, and anteromedially to, the supratemporal fenestra 1. present anterior to, or anteromedially to, the supratemporal fenestra

94	**Supratemporal fossa, anterior margin in dorsal view: (*)** *Young (2006, ch. 9 mod.); Wilkinson et al. (2008, ch. 28); Young & Andrade (2009, ch. 28); Young et al. (2011, ch. 28); Young et al. (2013a, ch. 32); Young et al. (2012, ch. 38); Young (2014, ch. 40); Young et al. (2016, ds 2, ch. 49); Ristevski et al. (2018, ds 2, ch. 73); Smith et al. (in review, ds 1, ch. 74); Ősi et al. (2018, ds 1, ch. 87).* *This character was designed to quantify the anterior extent of the supratemporal fossae. In Metriorhynchidae, the fossae begin to invade the dorsal surface of the orbital region. In* Dakosaurus*,* Purranisaurus potens, Cricosaurus saltillensis, *and* C. schroederi *the supratemporal fossae extend as far anteriorly as the minimum interorbital distance (state 3).* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. anterior margin terminates posterior to the postorbital 1. anterior margin terminates between the anterior and posterior points of the frontal-postorbital suture 2. anterior margin terminates level to the postorbital anterior margin 3. anterior margin projects more anteriorly than the postorbital and reaches the interorbital minimum distance
95	**Supratemporal fossae, overall shape: (*)** *Young & Andrade (2009, ch. 110 + 120 mod. part); Andrade et al. (2011, ch. 111 mod.); Young et al. (2011, ch. 110 + 120 mod. part); Young et al. (2013a, ch. 33 mod. part); Young et al. (2012, ch. 39 + 40 + 41 mod.); Young (2014, ch. 41 + 42 + 43); Young et al. (2016, ds 2, ch. 50 + 51 + 52 mod.); Ristevski et al. (2018, ds 2, ch. 74); Smith et al. (in review, ds 1, ch. 75); Ősi et al. (2018, ds 1, ch. 88).* *This character is an amalgam of character 111 from Andrade et al. (2011), and characters 50, 51 and 52 from Young et al. (2016, ds 2).* *In Thalattosuchia, state (1) is a putative apomorphy for* Teleosaurus cadomensis *and* Maledictosuchus ricalensis. *State (2) occurs in* Elosuchus *and* Vectisuchus*.* *In Thalattosuchia, state (4) is a putative apomorphy of* Cricosaurus araucanensis *and* C. vignaudi. *State (6) is a putative apomorphy of Machimosaurini*. *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. longitudinal ellipsoid/sub-rectangular (anteroposterior axis more than 10% longer than the lateromedial axis) 1. square-shaped to sub-rectangular (anteroposterior axis more than 10% longer than the lateromedial axis) 2. transverse triangle-shaped, with the axis converging medially (lateromedial axis more than 10% longer than the anteroposterior axis 3. circular to sub-circular 4. triangle-shaped, axis converging medially 5. parallelogram: lateral and medial margins, and anterior and posterior margins are sub-parallel
96	**Supratemporal fossa/fenestra, anterior margin shape, anterolateral expansion: (*)** *Ristevski et al. (2018, ds 2, ch. 75); Smith et al. (in review, ds 1, ch. 76); Ősi et al. (2018, ds 1, ch. 89).* *State (1) occurs in the teleosauroids* Mycterosuchus nasutus, Peipehsuchus teleorhinus*,* Platysuchus multiscrobiculatus*,* Teleosaurus cadomensis *and* Steneosaurus brevior. *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. no anterolateral expansion of the supratemporal fenestrae/fossae 1. anterior margin of the supratemporal fossae are noticeably inclined anterolaterally, such that the anterolateral corners of the supratemporal fossae are noticeably more anterior than the anteromedial corners of the supratemporal fossae
97	**Supratemporal fenestra, overall anteroposterior elongation: (*)** *Ristevski et al. (2018, ds 2, ch. 76); Smith et al. (in review, ds 1, ch. 77); Ősi et al. (2018, ds 1, ch. 90).* *State (1) occurs in derived teleosauroids.* *This character is not homologous to the anteroposterior elongation of the supratemporal fenestrae in other clades, as it is caused by the extreme*

	anteroposterior elongation of the proötics, laterosphenoids, postorbital posterior processes, parietal anterior process and frontal posterior process. *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. length is either less than, or approximately sub-equal to the anterior width 1. length is twice as long as the anterior width, or more. In *Machimosaurus*, the width of the supratemporal fenestrae increases, however the extreme elongation of the bones is still present.
98	**Supratemporal fenestra, overall anteroposterior elongation: (*)** *Ristevski et al. (2018, ds 2, ch. 77); Smith et al. (in review, ds 1, ch. 78); Ősi et al. (2018, ds 1, ch. 91).* *State (1) occurs in dyrosaurids.* *This character is not homologous to the anteroposterior elongation of the supratemporal fenestrae in teleosauroids, as it is caused by the anteroposterior elongation of the laterosphenoids, postorbital posterior processes, squamosal anterior processes and parietal anterior process.* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. length is either less than, or approximately sub-equal to the width at the middle of the fenestra (± 25%) 1. length is greater than the width of the fenestra (greater than 125%)
99	**Supratemporal fenestra, in dorsal view, size relative to orbits: (*)** *Young (2006, ch. 11); Wilkinson et al. (2008, ch. 30); Young & Andrade (2009, ch. 30); Young et al. (2011, ch. 30); Young et al. (2013a, ch. 34); Young et al. (2012, ch. 42); Young (2014, ch. 44); Young et al. (2016, ds 2, ch. 53); Ristevski et al. (2018, ds 2, ch. 78); Smith et al. (in review, ds 1, ch. 79); Ősi et al. (2018, ds 1, ch. 92).* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. longer in length than the orbit (supratemporal length 110% or more of orbit length) 1. subequal in length as the orbit (± 5%) 2. smaller than the orbits (supratemporal length less than 90% of orbit length)
100	**Supratemporal fenestra, in dorsal view, posterior limit: (*)** *Wilkinson et al. (2008, ch. 31 mod.); Young & Andrade (2009, ch. 31 mod.); Young et al. (2011, ch. 31 mod.); Young et al. (2013a, ch. 35 mod.); Young et al. (2012, ch. 43); Young (2014, ch. 45); Young et al. (2016, ds 2, ch. 54); Ristevski et al. (2018, ds 2, ch. 79); Smith et al. (in review, ds 1, ch. 80); Ősi et al. (2018, ds 1, ch. 93).* *State (2) is a putative apomorphy of the* Dakosaurus + Plesiosuchus *sub-clade.* *Note, scoring of this character should be done carefully, it may not be possible to score for skulls that have suffered taphonomic dorsoventral compression/shearing.* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. terminates well before the posterior-most point of the parietal 1. either terminates near the posterior-most point of the parietal or exceeds it, but never reaches the supraoccipital 2. more posterior than intertemporal bar
101	**Supratemporal fenestra/fossae, posterior margin in dorsal view: (*)** *Jouve et al. (2005b, ch. 10 mod.), Jouve (2005, ch. 6 mod.), Jouve et al. (2008, ch. 10 mod.), Hastings et al. (2010, ch. 10 mod.); Ristevski et al. (2018, ds 2, ch. 80); Smith et al. (in review, ds 1, ch. 81); Ősi et al. (2018, ds 1, ch. 94).* *State (1) occurs in derived dyrosaurids.* *This character is not applicable for taxa that lack the 'skull table' temporal morphotype, or taxa that lack supratemporal fenestrae.* 0. supratemporal fenestral posterior wall largely vertical and barely visible in dorsal view 1. supratemporal fenestral posterior wall posterodorsally inclined, creating a posterior fossa that is visible in dorsal view
102	**Supratemporal arch, medial margin in dorsal view: (*)** *Young & Andrade (2009, ch. 91); Young et al. (2011, ch. 91); Young et al. (2013a, ch. 37); Young et al. (2012, ch. 45); Young (2014, ch. 47); Young et al. (2016, ds 2, ch. 55); Ristevski et al. (2018, ds 2, ch. 81); Smith et al. (in review, ds 1, ch. 82); Ősi et al. (2018, ds 1, ch. 95).* *State (1) is a putative apomorphy of* 'Dakosaurus' lissocephalus + Cricosaurus. *This character is not applicable for taxa lacking supratemporal fenestrae.*

	0. not convex 1. convex
103	**Supratemporal arch, dorsal margin in lateral view: (*)** *Young & Andrade (2009, ch. 98); Young et al. (2011, ch. 98); Young et al. (2013a, ch. 38); Young et al. (2012, ch. 46); Young (2014, ch. 48); Young et al. (2016, ds2, ch. 56); Ristevski et al. (2018, ds 2, ch. 82); Smith et al. (in review, ds 1, ch. 83); Ősi et al. (2018, ds 1, ch. 96).* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. concave 1. straight 2. convex
104	**Supratemporal arch, width in dorsal view: (*)** *Jouve et al. (2005b, ch. 16 mod.), Jouve et al. (2008, ch. 16 mod.), Hastings et al. (2010, ch. 11 mod.); Ristevski et al. (2018, ds 2, ch. 83); Smith et al. (in review, ds 1, ch. 84); Ősi et al. (2018, ds 1, ch. 97).* *State (1) scores the thin supratemporal arches of Dyrosauridae (with some reversals).* *This character is not applicable for taxa that lack the 'skull table' temporal morphotype, or taxa that lack supratemporal fenestrae.* 0. thick 1. thin
105	**Prefrontal, dorsal surface lateral development: (ORDERED)** *Gasparini et al. (2006, ch. 247 mod.); Young (2006, ch. 2 mod.); Wilkinson et al. (2008, ch. 12); Jouve (2009, ch. 255 mod.); Young & Andrade (2009, ch. 12); Andrade et al. (2011, ch. 125 mod.); Young et al. (2011, ch. 12); Young et al. (2013a, ch. 39); Young et al. (2012, ch. 47); Young (2014, ch. 49); Young et al. (2016, ds 2, ch. 57); Ristevski et al. (2018, ds 2, ch. 84); Smith et al. (in review, ds 1, ch. 85); Ősi et al. (2018, ds 1, ch. 98).* *The transverse development of the prefrontal is a classic characteristic of Metriorhynchidae.* *State (1) is a putative apomorphy of* Eoneustes*, however it could be more widespread among basal metriorhynchoids.* *State (2) is a putative apomorphy of Metriorhynchidae.* 0. reduced, flush with the rim of the orbit 1. incipient enlargement (extending laterally over the orbit by approximately 5% of its width) 2. enlarged (extending laterally over the orbit by more than 15% of its width)
106	**Prefrontal, lateral development relative to the posterolateral corner of the supratemporal fossa in dorsal view: (*)** *Wilkinson et al. (2008, ch. 13 mod.); Young & Andrade (2009, ch. 13 mod.); Young et al. (2011, ch. 13 mod.); Young et al. (2013a, ch. 40); Young et al. (2012, ch. 48); Young (2014, ch. 50); Young et al. (2016, ds 2, ch. 58); Ristevski et al. (2018, ds 2, ch. 85); Smith et al. (in review, ds 1, ch. 86); Ősi et al. (2018, ds 1, ch. 99).* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. prefrontal does not expand laterally so that it is in the same plane as the posterolateral corner of the supratemporal fossa 1. prefrontal expands further laterally than the posterolateral corner of the supratemporal fossa
107	**Prefrontal, shape in dorsal view:** *Wilkinson et al. (2008, ch. 14 mod. part); Young & Andrade (2009, ch. 14 mod. part); Young et al. (2011, ch. 14 mod. part); Young et al. (2013a, ch. 41 mod. part); Young et al. (2012, ch. 49); Young (2014, ch. 51); Young et al. (2016, ds 2, ch. 59); Ristevski et al. (2018, ds 2, ch. 86); Smith et al. (in review, ds 1, ch. 87); Ősi et al. (2018, ds 1, ch. 100).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. quadrilateral with irregular outline 1. teardrop-shaped
108	**Prefrontal, morphology of the lateral border in dorsal view: (*)** *Wilkinson et al. (2008, ch. 14 mod. part); Young & Andrade (2009, ch. 14 mod. part); Young et al. (2011, ch. 14 mod. part); Young et al. (2013a, ch. 41 mod. part); Young et al. (2012, ch. 50); Young (2014, ch. 52); Young et al. (2016, ds 2, ch. 60);*

	Ristevski et al. (2018, ds 2, ch. 87); Smith et al. (in review, ds 1, ch. 88); Ősi et al. (2018, ds 1, ch. 101). *This character describes the shape of the prefrontal in Metriorhynchidae, and thus is not applicable for taxa that do not have the lateral expansion of the prefrontal.* Eoneustes*, metriorhynchines and basal geosaurines score as state (0).* *State (1) is a putative apomorphy of Geosaurini.* *State (2) is a putative apomorphy of* Dakosaurus *(a modification of the Geosaurini condition).* 0. continuous convex curve, inflexion point approximately 80–90 degree angle from the anteroposterior axis of the skull 1. continuous convex curve, inflexion point approximately 60–70 degree angle from the anteroposterior axis of the skull 2. continuous convex curve, inflexion point approximately 50 degree angle from the anteroposterior axis of the skull
109	**Prefrontal, dimensions in dorsal view:** *Wilkinson et al. (2008, ch. 15); Young & Andrade (2009, ch. 15); Young et al. (2011, ch. 15); Young et al. (2013a, ch. 42); Young et al. (2012, ch. 51); Young (2014, ch. 53); Young et al. (2016, ds2, ch. 61); Ristevski et al. (2018, ds 2, ch. 88); Smith et al. (in review, ds 1, ch. 89); Ősi et al. (2018, ds 1, ch. 102).* 0. longer than wide 1. length/width is subequal (± 5%)
110	**Prefrontal, anterior to the orbits:** *Wilkinson et al. (2008, ch. 16); Young & Andrade (2009, ch. 16); Young et al. (2011, ch. 16); Young et al. (2013a, ch. 43); Young et al. (2012, ch. 52); Young (2014, ch. 54); Young et al. (2016, ds 2, ch. 62); Ristevski et al. (2018, ds 2, ch. 89); Smith et al. (in review, ds 1, ch. 90); Ősi et al. (2018, ds 1, ch. 103).* 0. elongate, oriented parallel to antero-posterior axis of the skull 1. short and broad
111	**Prefrontal, nasal-prefrontal suture has a pronounced, rectangular 'concavity' (directed posteriorly):** *Young & Andrade (2009, ch. 93); Young et al. (2011, ch. 93); Young et al. (2013a, ch. 44); Young et al. (2012, ch. 53); Young (2014, ch. 55); Young et al. (2016, ds 2, ch. 63); Ristevski et al. (2018, ds 2, ch. 90); Smith et al. (in review, ds 1, ch. 91); Ősi et al. (2018, ds 1, ch. 104).* *State (1) is a putative apomorphy of* Eoneustes*.* 0. absent 1. present
112	**Prefrontal, nasal-prefrontal suture has a posteriorly directed 'V'-shape:** *Young & Andrade (2009, ch. 140); Young et al. (2011, ch. 140); Young et al. (2013a, ch. 45); Young et al. (2012, ch. 54); Young (2014, ch. 56); Young et al. (2016, ds 2, ch. 64); Ristevski et al. (2018, ds 2, ch. 91); Smith et al. (in review, ds 1, ch. 92); Ősi et al. (in review, ds 1, ch. 105).* *State (1) is a putative autapomorphy of* Cricosaurus macrospondylus*.* 0. absent 1. present
113	**Frontal, dorsal surface along the midline:** *Nesbitt (2011, ch. 42 mod.); Young et al. (2016, ds 2, ch. 66); Ristevski et al. (2018, ds 2, ch. 92); Smith et al. (in review, ds 1, ch. 93); Ősi et al. (2018, ds 1, ch. 106).* *State (0) is a putative apomorphy of Crocodyliformes (although there is a reversal in numerous neosuchian clades)* 0. flat 1. an incomplete longitudinal ridge along the midline 2. a longitudinal ridge that proceeds along the entire length of the midline
114	**Frontal, dorsal surface:** *Young et al. (2016, ds 2, ch. 67); Ristevski et al. (2018, ds 2, ch. 93); Smith et al. (in review, ds 1, ch. 94); Ősi et al. (2018, ds 1, ch. 107).* *State (1) occurs in* Hesperosuchus *cf.* agilis, Dromicosuchus grallator, *and among many tethysuchians (except derived dyrosaurids)* 0. slightly convex or flat 1. concave, with the medial borders of the orbit upturned
115	**Frontal, anteromedial process length: (*)**

	Jouve et al. (2008, ch. 31 mod.), Hastings et al. (2010, ch. 38 mod.); Ristevski et al. (2018, ds 2, ch. 94); Smith et al. (in review, ds 1, ch. 95); Ősi et al. (2018, ds 1, ch. 108). *This character is not applicable for* Anthracosuchus *and* Cerrejonisuchus *as the anterior region of the frontal is elongated and the prefrontals are reduced (i.e. there is no elongation of the anteromedial process).* 0. the anteromedial process is approximately level to, or slightly posterior to, the prefrontals 1. the anteromedial process is noticeably posterior to the prefrontals
116	**Frontal, anteromedial process:** *Young et al. (2016, ds 2, ch. 68); Ristevski et al. (2018, ds 2, ch. 95); Smith et al. (in review, ds 1, ch. 96); Ősi et al. (2018, ds 1, ch. 109).* *State (1) is a putative apomorphy of Sebecia, also occurs in some basal dyrosaurids, bernissartiids and hylaeochampsids.* 0.frontal anteromedial process has an acute anterior margin, which separates the left and right nasals along their posterior margin 1. frontal anteromedial process lacks an acute anterior margin, with the nasal posterior margin with the frontal being either transversely straight, or is slightly convex or concave (in taxa where the prefrontals expand anterolaterally, there can sometimes be posteromedial processes of the nasals)
117	**Frontal, contribution to the intertemporal bar: (*)** *Smith et al. (in review, ds 1, ch. 97); Ősi et al. (2018, ds 1, ch. 110).* *This character is not applicable for taxa that lack supratemporal fenestrae.* *Note that in many crocodyliforms the frontal only forms the very anterior region of the intersupratemporal fenestral area. We only score taxa as state (1) if the frontal is clearly anterior to the bar.* *State (1) occurs in* Protosuchus*,* Mahajangasuchus*,* Elosuchus*,* Vectisuchus*,* Chalawan thailandicus*,* Sarcosuchus*, and Crocodylia.* 0. frontal contributes to the anterior part of the intertemporal bar 1. frontal is excluded from the intertemporal bar, with the bar being solely composed by the parietal
118	**Frontal, angle between posteromedial and posterolateral processes: (*)** *Wilkinson et al. (2008, ch. 26 mod.); Young & Andrade (2009, ch. 26 mod.); Andrade et al. (2011, ch. 98 mod.); Young et al. (2011, ch. 26); Young et al. (2013a, ch. 47); Young et al. (2012, ch. 56); Young (2014, ch. 58); Young et al. (2016, ds 2, ch. 69); Ristevski et al. (2018, ds 2, ch. 96); Smith et al. (in review, ds 1, ch. 98); Ősi et al. (2018, ds 1, ch. 111).* *See diagrammatic explanation for this character in Wilkinson et al. (2008: p.1311, Fig. 4).* *This character is not applicable for taxa that lack supratemporal fenestrae (which help form the distinct posterior processes of the frontal).* 0. approximately 90 degree angle, or obtuse 1. approximately 70–60 degree angle 2. approximately 45 degree angle, or more acute
119	**Frontal, minimum width between orbits in dorsal view compared to the supratemporal fossa: (*)** *Young & Andrade (2009, ch. 121); Young et al. (2011, ch. 121); Young et al. (2013a, ch. 48); Young et al. (2012, ch. 57); Young (2014, ch. 59); Young et al. (2016, ds 2, ch. 70); Ristevski et al. (2018, ds 2, ch. 97); Smith et al. (in review, ds 1, ch. 99); Ősi et al. (2018, ds 1, ch. 112).* *This character is not applicable for taxa that lack supratemporal fenestrae.* 0. greater than, or equal to, the width of one supratemporal fossa and the intertemporal bar 1. subequal to width of one supratemporal fossa
120	**Frontal, minimum width between orbits in dorsal view compared to the orbits:** *Young & Andrade (2009, ch. 137); Young et al. (2011, ch. 137); Young et al. (2013a, ch. 49); Young et al. (2012, ch. 58); Young (2014, ch. 60); Young et al. (2016, ds 2, ch. 71); Ristevski et al. (2018, ds 2, ch. 98); Smith et al. (in review, ds 1, ch. 100); Ősi et al. (2018, ds 1, ch. 113).* 0. broader than orbital width 1. subequal with orbital width

	2. narrower than orbital width
121	**Frontal-parietal, between supratemporal fossa in dorsal view (intertemporal bar): (*)** *Wilkinson et al. (2008, ch. 2); Young & Andrade (2009, ch. 2); Young et al. (2011, ch. 2); Young et al. (2013a, ch. 50); Young et al. (2012, ch. 59); Young (2014, ch. 61); Young et al. (2016, ds 2, ch. 72); Ristevski et al. (2018, ds 2, ch. 99); Smith et al. (in review, ds 1, ch. 101); Ősi et al. (2018, ds 1, ch. 114).* *This character is not applicable for taxa that lack supratemporal fenestrae (as there is no intertemporal bar).* 0. frontal and parietal subequal in width (± 5%) 1. frontal width is wider than the parietal. Can be extreme (greater than 75%)
122	**Frontal-postorbital suture: (*)** *Wilkinson et al. (2008, ch. 27 mod.); Young & Andrade (2009, ch. 27 mod.); Young et al. (2011, ch. 27); Young et al. (2013a, ch. 51); Young et al. (2012, ch. 60); Young (2014, ch. 62); Young et al. (2016, ds 2, ch. 73); Ristevski et al. (2018, ds 2, ch. 100); Smith et al. (in review, ds 1, ch. 102); Ősi et al. (2018, ds 1, ch. 115).* *This character is not applicable for taxa that lack supratemporal fenestrae (as there is no intertemporal bar).* 0. level with the intertemporal bar 1. lower than the intertemporal bar
123	**Frontal-postorbital suture, in dorsal view:** *Wilkinson et al. (2008, ch. 3 mod.); Young & Andrade (2009, ch. 3 mod.); Hastings et al. (2010, ch. 40 mod.); Young et al. (2011, ch. 3 mod.); Young et al. (2013a, ch. 52 mod.); Young et al. (2012, ch. 61 mod.); Young (2014, ch. 63 mod.); Young et al. (2016, ds 2, ch. 74 mod.); Ristevski et al. (2018, ds 2, ch. 101); Smith et al. (in review, ds 1, ch. 103); Ősi et al. (i2018, ds 1, ch. 116).* *This character is an amalgam of the Hastings et al. (2010, ch. 40) and Young et al. (2016, ds 2, ch. 74) characters.* *State (1) is a putative apomorphy of Metriorhynchidae.* *State (2) scores the dyrosaurid morphotype.* 0. irregular and straight or gently curved 1. frontal overlaps the postorbital, creating a 'V'-shape directed posteriorly. 2. strongly interdigitating in dorsal view (largely in one plane)
124	**Postorbital, shape in dorsal view:** *Young & Andrade (2009, ch. 118); Young et al. (2011, ch. 118); Young et al. (2013a, ch. 53); Young et al. (2012, ch. 62); Young (2014, ch. 64); Young et al. (2016, ds 2, ch. 75); Ristevski et al. (2018, ds 2, ch. 102); Smith et al. (in review, ds 1, ch. 104); Ősi et al. (2018, ds 1, ch. 117).* 0. the outer margin is convex where the postorbital curves posteriorly forming the supratemporal arch 1. forms a 90 degree angle 2. anterior extension from the corner
125	**Postorbital, anterolateral extension:** *Young & Andrade (2009, ch. 138); Young et al. (2011, ch. 138); Young et al. (2013a, ch. 54); Young et al. (2012, ch. 63); Young (2014, ch. 65); Young et al. (2016, ds 2, ch. 76); Ristevski et al. (2018, ds 2, ch. 103); Smith et al. (in review, ds 1, ch. 105); Ősi et al. (2018, ds 1, ch. 118).* *State (1) of this character, and state (2) of the character "anterior extension from the postorbital corner" do not necessarily occur in the same taxon (e.g.* Oceanosuchus*).* 0. small or absent 1. very large, appearing in lateral view to contact the dorsal surface of the jugal
126	**Postorbital and squamosal, relative lengths in dorsal view:** *Young (2006, ch. 15); Wilkinson et al. (2008, ch. 37); Young & Andrade (2009, ch. 37); Young et al. (2011, ch. 37); Young et al. (2013a, ch. 55); Young et al. (2012, ch. 64); Young (2014, ch. 66); Young et al. (2016, ds 2, ch. 77); Ristevski et al. (2018, ds 2, ch. 104); Smith et al. (in review, ds 1, ch. 106); Ősi et al. (2018, ds 1, ch. 119).* *State (1) is a putative apomorphy of Thalattosuchia.* 0. squamosal is longer 1. postorbital is longer

127	**Supratemporal arch (= upper temporal bar), relative participation of the postorbital:** *Ortega et al. (2000, ch. 33 mod.); Andrade et al. (2011, ch. 151); Ristevski et al. (2018, ds 2, ch. 105); Smith et al. (in review, ds 1, ch. 107); Ősi et al. (2018, ds 1, ch. 120).* *Young & Andrade (2009, ch. 127); Young et al. (2011, ch. 127); Young et al. (2013a, ch. 57); Young et al. (2012, ch. 66); Young (2014, ch. 68) and Young et al. (2016, ch. 79) score for the same morphology, however they used the squamosal contribution to the supratemporal arch.* *State (1) is putative apomorphy of Thalattosuchia.* *Note that a similar morphology also evolves in some derived dyrosaurids (elongatation of the postorbital posterior processes). In these taxa however, the character relating to the relative participation of the postorbital is not affected (i.e. the squamosal in dorsal view is still longer anteroposteriorly than the postorbital). The postorbital being longer overall, and makes a greater proportional contribution to the supratemporal arch than the squamosal, only co-occurs in Thalattosuchia.* 0. small, postorbital represents approximately 30% of the bar 1. extensive, postorbital represents approximately 50% (or more) of the bar
128	**Posterior margin of the squamosal lateral to post-temporal fenestrae:** *Jouve et al. (2005b, ch. 29), Jouve et al. (2008, ch. 29), Hastings et al. (2010, ch. 48); Ristevski et al. (2018, ds 2, ch. 106); Smith et al. (in review, ds 1, ch. 108); Ősi et al. (2018, ds 1, ch. 121).* *State (1) occurs in derived dyrosaurids.* 0. straight 1. anteriorly concave
129	**Squamosal, projects further posteriorly than the occipital condyle:** *Young & Andrade (2009, ch. 125); Young et al. (2011, ch. 125); Young et al. (2013a, ch. 56); Young et al. (2012, ch. 65); Young (2014, ch. 67); Young et al. (2016, ds 2, ch. 78); Ristevski et al. (2018, ds 2, ch. 107); Smith et al. (in review, ds 1, ch. 109); Ősi et al. (2018, ds 1, ch. 122).* 0. no 1. yes
130	**Squamosal dorsolateral edge, longitudinal groove:** *Young & Andrade (2009, ch. 112 part); Nesbitt (2011, ch. 53); Young et al. (2011, ch. 112 part); Young et al. (2013a, ch. 58 part); Young et al. (2012, ch. 67 part); Young (2014, ch. 69 part); Young et al. (2016, ds 2, ch. 80); Ristevski et al. (2018, ds 2, ch. 108); Smith et al. (in review, ds 1, ch. 110); Ősi et al. (2018, ds 1, ch. 123).* *State (1) is a putative apomorphy of Crocodyliformes (reversals in Thalattosuchia and* Iharkutosuchus makadii*), but also occurs in some 'sphenosuchians'.* 0. absent 1. present
131	**Squamosal dorsolateral edge, longitudinal groove margins: (*)** *Young & Andrade (2009, ch. 112 part); Young et al. (2011, ch. 112 part); Young et al. (2013a, ch. 58 part); Young et al. (2012, ch. 67 part); Young (2014, ch. 69 part); Young et al. (2016, ds 2, ch. 81); Ristevski et al. (2018, ds 2, ch. 109); Smith et al. (in review, ds 1, ch. 111); Ősi et al. (2018, ds 1, ch. 124).* *This character is not applicable for taxa that lack the squamosal longitudinal groove.* 0. ventral margin of the groove projects more laterally than the dorsal margin 1. ventral margin is directly underneath the dorsal margin
132	**Parietals, in presumed adults:** *Nesbitt (2011, ch. 58); Young et al. (2016, ds 2, ch. 82); Ristevski et al. (2018, ds 2, ch. 110); Smith et al. (in review, ds 1, ch. 111); Ősi et al. (2018, ds 1, ch. 125).* 0. separate 1. interparietal suture partially or completely absent (i.e. surface fusion)
133	**Parietals, supratemporal (= dorsotemporal) fenestrae separated by: (*)** *Clark et al. (2000, ch. 17 mod.); Clark & Sues (2002, ch. 18 mod.); Sues et al. (2003, ch. 18 mod.); Clark et al. (2004, ch. 18 mod.); Nesbitt (2011, ch. 59 mod.); Pol et al. (2013, ch. 18 mod.); Young et al. (2016, ds 2, ch. 83 mod.); Leardi et al. (2017, ch. 18 mod.); Ristevski et al. (2018, ds 2, ch. 111); Smith et al. (in review, ds 1, ch. 113); Ősi et al. (2018, ds 1, ch. 126).* *Ősi et al. (2018) added state (3).*

	State (3) occurs in Dromicosuchus *and* Hesperosuchus *cf*. agilis. *This character is not applicable for taxa that lack the supratemporal fenestrae.* 0. broad, flat area 1. supratemporal fossa separated by a mediolaterally thin strip of flat bone 2. supratemporal fossa separated by a ‘‘sagittal crest’’ (which may be divided by the interparietal suture) 3. supratemporal fossa separated by a median longitudinal groove between paired parietal crests
134	**Intertemporal bar (= frontoparietal), modification of the “sagittal crest”: (*)** *Ristevski et al. (2018, ds 2, ch. 112); Smith et al. (in review, ds 1, ch. 114); Ősi et al. (2018, ds 1, ch. 127).* *Character following Jouve et al. (2005a: figure 8), Hastings et al. (2010, ch. 9).* *Note this character scores the distinct thin intertemporal bar of derived dyrosaurids. In Thalattosuchia the bar is not consistently thin along its entire length (being noticeably broad anteriorly).* *This character is not applicable for taxa that lack the supratemporal fenestrae.* 0. either not a “sagittal crest”, or does not have the derived dyrosaurid morphotype 1. has the derived dyrosaurid morphotype: the intertemporal bar is composed of the frontal posterior process anteriorly and the parietal anterior process in the middle-and-posterior region, with a consistently thin bar along its entire length, and lateral margins deeply excavated creating a broad lateral supratemporal fossa
135	**Parietal, bifurcation of the parietal in dorsal view, immediately posterior to the intertemporal bar:** *Young et al. (2016, ds 2, ch. 84); Ristevski et al. (2018, ds 2, ch. 113); Smith et al. (in review, ds 1, ch. 115); Ősi et al. (2018, ds 1, ch. 128).* *State (1) is found in* ‘Dakosaurus’ lissocephalus, Cricosaurus araucanensis, C. elegans, C. lithographicus, C. schroederi *and* C. vignaudi. *This character replaces the character that described the posterior margin of the parietal-squamosal in dorsal view – Wilkinson et al. (2008, ch. 42); Young & Andrade (2009, ch. 42); Young et al. (2011, ch. 42); Young et al. (2013a, ch. 59); Young et al. (2012, ch. 68); Young (2014, ch. 70).* 0. absent 1. present
136	**Parietals, posterodorsal margin:** *Jouve (2005, ch. 7 mod.), Jouve et al. (2005b, ch. 11 mod.), Jouve et al. (2008, ch. 11 mod.), Hastings et al. (2010, ch. 42 mod.); Ristevski et al. (2018, ds 2, ch. 114); Smith et al. (in review, ds 1, ch. 116); Ősi et al. (2018, ds 1, ch. 129).* *State (1) occurs in derived dyrosaurids.* 0. transversely oriented 1. indented anteriorly
137	**Parietals, posteroventral edge:** *Nesbitt (2011, ch. 60); Young et al. (2016, ds 2, ch. 85); Ristevski et al. (2018, ds 2, ch. 115); Smith et al. (in review, ds 1, ch. 117); Ősi et al. (2018, ds 1, ch. 130).* *State (1) is a putative apomorphy of Crocodyliformes.* 0. extending more than half the width of the occiput 1. extending less than half the width of the occiput
138	**Post-temporal fenestrae obscured in dorsal view by an overhanging posterior extension of the parietal:** *Jouve et al. (2008, ch. 34 mod.); Hastings et al. (2010, ch. 46 mod.); Ristevski et al. (2018, ds 2, ch. 116); Smith et al. (in review, ds 1, ch. 118); Ősi et al. (2018, ds 1, ch. 131).* *State (1) occurs in derived dyrosaurids.* 0. absent 1. present
139	**Parietal in occipital view:** *Jouve et al. (2008, ch. 32 mod.); Hastings et al. (2010, ch. 44 mod.); Ristevski et al. (2018, ds 2, ch. 117); Smith et al. (in review, ds 1, ch. 119); Ősi et al. (2018, ds 1, ch. 132).* 0. ‘W-shaped’ 1. concave 2. flat or convex

Orbit and temporal region (Ch. 140 – 168; 6.304% of characters)
[orbit, circumorbital contributions, ossa palpebralia, ossa scleroticalia, dermatocranial bones (= ossa jugalia, ossa postfrontalia, postorbital bars and ossa quadratojugalia), infratemporal fenestrae]

#	Description
140	**Orbit, position:** *Young (2006, ch. 3 mod.); Wilkinson et al. (2008, ch. 18 mod.); Young & Andrade (2009, ch. 18 mod.); Andrade et al. (2011, ch. 157 mod.); Young et al. (2011, ch. 18); Young et al. (2013a, ch. 60); Young et al. (2012, ch. 69); Young (2014, ch. 71); Young et al. (2016, ds 2, ch. 86); Ristevski et al. (2018, ds 2, ch. 118); Smith et al. (in review, ds 1, ch. 120); Ősi et al. (2018, ds 1, ch. 133).* *Note, when scoring the orientation of the orbits, the palpebrals must not be considered.* 0. fully dorsal 1. mainly dorsal, but with slight inclination 2. lateral, but slightly inclined dorsally, usually visible in dorsal view 3. fully lateral with orbit shape only clear in lateral view
141	**Orbit, shape:** *Young & Andrade (2009, ch. 96); Young et al. (2011, ch. 96); Young et al. (2013a, ch. 61); Young et al. (2012, ch. 70); Young (2014, ch. 72); Young et al. (2016, ds 2, ch. 87); Ristevski et al. (2018, ds 2, ch. 119); Smith et al. (in review, ds 1, ch. 121); Ősi et al. (2018, ds 1, ch. 134).* 0. circular, anteroposterior and dorsoventral axes subequal (± 5%) 1. longitudinal ellipsoid, anteroposterior axis more than 10% longer than mediolateral axis 2. transverse ellipsoid, mediolateral axis more than 10% longer than anteroposterior axis
142	**Circumorbital dorsal margin, shape:** *Brochu (1999, ch. 103 mod.); Salas-Gismondi et al. (2016, ch. 137 mod.); Smith et al. (in review, ds 1, ch. 122); Ősi et al. (2018, ds 1, ch. 135).* *For an explanation of this character see Figure 7 in Salas-Gismondi et al. (2016).* *State (1) occurs in the French* Pholidosaurus specimen*,* Elosuchus*,* Teleosaurus cadomensis*,* Mycterosuchus nasutus*.* *State (2) occurs in* Vectisuchus*,* Sarcosuchus*,* Gavialis gangeticus*.* Chalawan thailandicus *has evidence of the dorsal medial margin being upturned, but the posterior margins of the orbits are not preserved (Martin et al., 2014)*. *Note this character is not equivalent to having a concave frontal, as here it is the upturning of the orbital margins that are being scored. Among many taxa with 'telescoped' orbits the frontal is also concave, but not all tethysuchians with concave frontals have the 'telescoped' orbit condition.* *This character helps to quantify the 'telescoped' orbit morphology.* 0. dorsal margins of orbits are flush with the skull dorsal surface 1. dorsal margins of orbits upturned (prominent along the orbital medial margin in dorsal view, with the frontal interorbital margins being upturned) 2. dorsal and posterior margins are upturned (the frontal lateral process anterior margins are also upturned)
143	**Circumorbital ventral margin, shape:** *Salas-Gismondi et al. (2016, ch. 138 mod.); Smith et al. (in review, ds 1, ch. 123); Ősi et al. (i2018, ds 1, ch. 136).* *State (1) occurs in* Vectisuchus*,* Sarcosuchus*,* Gavialis gangeticus*.* Chalawan thailandicus *has evidence of the dorsal medial margin being upturned, but the anterior margins of the orbits are not preserved (Martin et al., 2014)*. *State (1) is caused by the 'upturning' of the preorbital bones (in particular the lachrymals), changing the shape of the anterior orbit margin. As shown by Salas-Gismondi et al. (2016) the accumulation of characters relating to orbital 'telescoping' is gradual, thus not all taxa will score for all character states relating to this morphofunctional complex.* *This character helps to quantify the 'telescoped' orbit morphology.*

	0. ventral margin of the orbit is either concave or sub-straight 1. ventral margin of the orbit has a prominent notch
144	**Orbit, anterodorsal margin and the lachrymal:** *Young & Andrade (2009, ch. 124 part); Young et al. (2011, ch. 124 part); Young et al. (2013a, ch. 62 part); Young et al. (2012, ch. 71); Young (2014, ch. 73); Young et al. (2016, ds 2, ch. 88); Ristevski et al. (2018, ds 2, ch. 120); Smith et al. (in review, ds 1, ch. 124); Ősi et al. (2018, ds 1, ch. 137).* *In Thalattosuchia, state (1) is a putative autapomorphy of* Teleidosaurus calvadosii 0. lachrymal is excluded from the orbit anterodorsal margin 1. lachrymal reaches the orbit anterodorsal margin
145	**Orbit, posterodorsal margin and the postorbital:** *Young & Andrade (2009, ch. 124 part); Young et al. (2011, ch. 124 part); Young et al. (2013a, ch. 62 part); Young et al. (2012, ch. 72); Young (2014, ch. 74); Young et al. (2016, ds 2, ch. 89); Ristevski et al. (2018, ds 2, ch. 121); Smith et al. (in review, ds 1, ch. 125); Ősi et al. (2018, ds 1, ch. 138).* *In Thalattosuchia, state (1) is a putative apomorphy of the clade* Teleidosaurus + *Metriorhynchidae* 0. postorbital is excluded from the orbit posterodorsal margin 1. postorbital reaches the orbit posterodorsal margin
146	**Orbit, anteroventral margin and the lachrymal:** *Young & Andrade (2009, ch. 95 part); Young et al. (2011, ch. 95 part); Young et al. (2013a, ch. 63 part); Young et al. (2012, ch. 73); Young (2014, ch. 75); Young et al. (2016, ds 2, ch. 90); Ristevski et al. (2018, ds 2, ch. 122); Smith et al. (in review, ds 1, ch. 126); Ősi et al. (2018, ds 1, ch. 139).* 0. lachrymal is excluded from the orbit anteroventral margin 1. lachrymal reaches the orbit anteroventral margin
147	**Orbit, anterior margin and the jugal anterior process:** *Ristevski et al. (2018, ds 2, ch. 123); Smith et al. (in review, ds 1, ch. 127); Ősi et al. (2018, ds 1, ch. 140).* *State (1) is a putative apomorphy of* Goniopholis *and* Anteophthalmosuchus. 0. the jugal anterior process does not contribute to the anterior margin of the orbit 1. the jugal anterior process, along with the lachrymal, forms the anterior margin of the orbit. Note that the broad anterior expansion of the jugal anterior process only occurs in *Goniopholis*, as *Anteophthalmosuchus* has a narrow jugal anterior process.
148	**Orbit, anterior margin and the broadening of the jugal anterior process:** *Ristevski et al. (2018, ds 2, ch. 124); Smith et al. (in review, ds 1, ch. 128); Ősi et al. (2018, ds 1, ch. 141).* *State (1) is a putative apomorphy of* Goniopholis 0. the jugal anterior process does not help form the anterior margin of the orbit, or as in *Anteophthalmosuchus*, it does help for the anterior margin of the orbit – but the jugal anterior process is still narrow 1. the jugal anterior process, along with the lachrymal, forms the anterior margin of the orbit, but it is distinctly broad dorsoventrally – expanded having a broad contact with the lachrymal dorsally and the maxilla anteriorly, much more so than in other derived goniopholidids.
149	**Orbit, posteroventral margin and the postorbital:** *Young & Andrade (2009, ch. 95 part); Young et al. (2011, ch. 95 part); Young et al. (2013a, ch. 63 part); Young et al. (2012, ch. 74); Young (2014, ch. 76); Young et al. (2016, ds 2, ch. 91); Ristevski et al. (2018, ds 2, ch. 125); Smith et al. (in review, ds 1, ch. 129); Ősi et al. (2018, ds 1, ch. 142).* *In Thalattosuchia, state (1) occurs in basal teleosauroids (*Steneosaurus brevior, *the Chinese skull referred to* Peipehsuchus teleorhinus, Platysuchus multiscrobiculatus *and* Teleosaurus cadomensis). *Note that some dorsoventral crushed skulls also look as though they have state (1), e.g.* S. bollensis. 0. postorbital is excluded from the orbit posteroventral margin, or only present in the posteroventral margin 1. postorbital reaches the orbit posteroventral margin (with the postorbital overlapping the jugal), and extensively forms part of the orbit ventral margin (in some instances excluding the jugal)
150	**Orbit, ventral margin and the jugal:**

	Mueller-Töwe (2006, ch. 139 mod.); Young & Andrade (2009, ch. 95 part); Andrade et al. (2011, ch. 171 mod.); Young et al. (2011, ch. 95 part); Young et al. (2013a, ch. 63 part); Young et al. (2012, ch. 75); Young (2014, ch. 77); Young et al. (2016, ds 2, ch. 92); Ristevski et al. (2018, ds 2, ch. 126); Smith et al. (in review, ds 1, ch. 130); Ősi et al. (2018, ds 1, ch. 143). *In Thalattosuchia, state (1) is a putative autapomorphy of* Platysuchus multiscrobiculatus 0. jugal participates in the orbit ventral margin 1. jugal excluded from the orbit by lachrymal-postorbital contact
151	**Supraorbital notch in dorsal view, deeply excavated creating an approximately semi-circular shape, resulting in the frontal being broadly exposed along the lateral margin of the orbits: (*)** *Young et al. (2016, ds 2, ch. 93); Ristevski et al. (2018, ds 2, ch. 127); Smith et al. (in review, ds 1, ch. 131); Ősi et al. (2018, ds 1, ch. 144).* *State (1) is a putative apomorphy of a subclade within Rhacheosaurini.* *This character is not applicable for non-metriorhynchids, due to the unique formation of the supraorbital notch in Metriorhynchidae.* 0. absent 1. present
152	**Supraorbital notch in dorsal view, very small, being a tight "U"-shape, created by the prefrontal being expanded posteriorly. This results in the prefrontal making a larger contribution to the orbit dorsal margin and the frontal contribution to the orbit dorsal margin is greatly reduced, and in some taxa being excluded from the centre of the orbital dorsal margin: (*)** *Young et al. (2016, ds 2, ch. 94); Ristevski et al. (2018, ds 2, ch. 128); Smith et al. (in review, ds 1, ch. 132); Ősi et al. (2018, ds 1, ch. 145).* *State (1) is occurs in* Metriorhynchus palpebrosus*,* Cricosaurus saltillensis *and* C. macrospondylus. *This character is not applicable for non-metriorhynchids, due to the unique formation of the supraorbital notch in Metriorhynchidae.* 0. absent 1. present
153	**Palpebrals, presence and number:** *Clark (1994, ch. 65 mod.); Young (2006, ch. 52 mod.); Turner & Buckley (2008, ch. 65); Wilkinson et al. (2008, ch. 17 mod.); Young & Andrade (2009, ch. 17 mod.); Andrade et al. (2011, ch. 186); Young et al. (2011, ch. 17 mod.); Young et al. (2013a, ch. 64 mod.); Young et al. (2012, ch. 76 mod.); Young (2014, ch. 78 mod.); Young et al. (2016, ds2, ch. 95 mod.); Ristevski et al. (2018, ds 2, ch. 129); Smith et al. (in review, ds 1, ch. 133); Ősi et al. (2018, ds 1, ch. 146).* *Andrade et al. (2011) modified this character to exclude information about size, which can be sampled as a separate character. The presence and morphology of palpebrals is here considered to be highly devious within the analysis, always poorly sampled and including assumptions (e.g., putative fusion with prefrontals vs putative loss in thalattosuchians). Preservation and incomplete descriptions contribute to a poor use of information as a character. Scores were considered only for taxa that actually show meaningful information. The putative absence of palpebrals in thalattosuchians has long been assumed (e.g., Fraas, 1901; Andrews, 1913), but it is actually not possible to exclude that this element may be deeply fused with prefrontal, leading to this modified version of state (0).* *Can be determined by the sutural contacts along the periorbital margin.* 0. absent, or (anterior) palpebral is deeply fused with prefrontal 1. one large (anterior) palpebral present 2. two large palpebrals (anterior and posterior) present
154	**Orbits, presence of sclerotic ossicles (composing the sclerotic ring):** *Young (2006, ch. 4); Wilkinson et al. (2008, ch. 19); Young & Andrade (2009, ch. 19); Andrade et al. (2011, ch. 159); Young et al. (2011, ch. 19); Young et al. (2013a, ch. 65); Young et al. (2012, ch. 77); Young (2014, ch. 79); Young et al. (2016, ds 2, ch. 96); Ristevski et al. (2018, ds 2, ch. 130); Smith et al. (in review, ds 1, ch. 134); Ősi et al. (2018, ds 1, ch. 147).* *Within Thalattosuchia, state (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.*

	0. absent 1. present
155	**Jugal, width of anterior process relative to posterior process:** *Young & Andrade (2009, ch. 111); Young et al. (2011, ch. 111); Young et al. (2013a, ch. 66); Young et al. (2012, ch. 78); Young (2014, ch. 80); Young et al. (2016, ds 2, ch. 97); Ristevski et al. (2018, ds 2, ch. 131); Smith et al. (in review, ds 1, ch. 135); Ősi et al. (2018, ds 1, ch. 148).* 0. subequal 1. about twice as broad
156	**Jugal, anterior process is sigmoidal with a noticeable convexity along its dorsal margin:** *Ristevski et al. (2018, ds 2, ch. 132); Smith et al. (in review, ds 1, ch. 136); Ősi et al. (2018, ds 1, ch. 149).* *State (1) is found in* Dakosaurus + *the Vaches Noire dakosaur*. 0. absent 1. present
157	**Jugal, extends anteriorly in front of the prefrontal:** *Young & Andrade (2009, ch. 94); Young et al. (2011, ch. 94); Young et al. (2013a, ch. 67); Young et al. (2012, ch. 79); Young (2014, ch. 81); Young et al. (2016, ds 2, ch. 98); Ristevski et al. (2018, ds 2, ch. 133); Smith et al. (in review, ds 1, ch. 137); Ősi et al. (2018, ds 1, ch. 150).* 0. no 1. yes
158	**Postorbital bar, inclination:** *Jouve et al. (2008, ch. 35 mod.); Young & Andrade (2009, ch. 85 mod.); Hastings et al. (2010, ch. 50 mod.); Young et al. (2011, ch. 85 mod.); Young et al. (2013a, ch. 68 mod.); Young et al. (2012, ch. 80 mod.); Young (2014, ch. 82 mod.d); Ristevski et al. (2018, ds 2, ch. 134); Smith et al. (in review, ds 1, ch. 138); Ősi et al. (2018, ds 1, ch. 151).* 0. strongly anterodorsally inclined 1. slightly anterodorsally inclined 2. nearly vertical 3. posterodorsally inclined
159	**Jugal, well-developed (i.e. greatly enlarged) foramen on the anterior ramus:** *Ristevski et al. (2018, ds 2, ch. 135); Smith et al. (in review, ds 1, ch. 139); Ősi et al. (2018, ds 1, ch. 152).* *State (1) occurs in derived dyrosarids.* 0. no 1. yes
160	**Postfrontal:** *Nesbitt (2011, ch. 44); Young et al. (2012, ch. 81); Young (2014, ch. 83); Young et al. (2016, ds 2, ch. 100); Ristevski et al. (2018, ds 2, ch. 136); Smith et al. (in review, ds 1, ch. 140); Ősi et al. (2018, ds 1, ch. 153).* *State (1) is a putative apomorphy of Crocodylomorpha.* 0. present 1. absent
161	**Postorbital bar, morphology of dorsal end:** *Young & Andrade (2009, ch. 90); Young et al. (2011, ch. 90); Young et al. (2013a, ch. 69); Young et al. (2012, ch. 82); Young (2014, ch. 84); Young et al. (2016, ds 2, ch. 101); Ristevski et al. (2018, ds 2, ch. 137); Smith et al. (in review, ds 1, ch. 141); Ősi et al. (2018, ds 1, ch. 154).* 0. dorsal end of the postorbital bar broadens dorsally, continuous with dorsal part of the postorbital 1. dorsal part of the postorbital bar constricted, distinct from the dorsal part of the postorbital
162	**Postorbital bar (postorbital), presence of a vascular opening at the lateral edge of the bar, close to the dorsal surface of the postorbital:** *Clark (1994, ch. 27); Young & Andrade (2009, ch. 114); Andrade et al. (2011, ch. 202); Young et al. (2011, ch. 114); Young et al. (2013a, ch. 70); Young et al. (2012, ch. 83); Young (2014, ch. 85); Young et al. (2016, ds 2, ch. 102); Ristevski et al.*

	(2018, ds 2, ch. 138); Smith et al. (in review, ds 1, ch. 142); Ősi et al. (2018, ds 1, ch. 155). *Note that scoring of state (0) can be highly influenced by preservation.* 0. absent 1. present
163	**Postorbital bar, morphology of postorbital-jugal contact:** *Wilkinson et al. (2008, ch. 35); Young & Andrade (2009, ch. 35); Young et al. (2011, ch. 35); Young et al. (2013a, ch. 71); Young et al. (2012, ch. 84); Young (2014, ch. 86); Young et al. (2016, ds 2, ch. 103); Ristevski et al. (2018, ds 2, ch. 139); Smith et al. (in review, ds 1, ch. 143) Ősi et al. (2018, ds 1, ch. 156).* 0. postorbital medial to jugal 1. postorbital lateral to jugal
164	**Postorbital bar, structure:** *Clark (1994, ch. 26 mod.); Wilkinson et al. (2008, ch. 36 mod.); Young & Andrade (2009, ch. 36 mod.); Young et al. (2011, ch. 36 mod.); Young et al. (2013a, ch. 72 mod.); Young et al. (2012, ch. 85 mod.); Young (2014, ch. 87 mod.); Young et al. (2016, ds 2, ch. 104 mod.); Ristevski et al. (2018, ds 2, ch. 140); Smith et al. (in review, ds 1, ch. 144); Ősi et al. (2018, ds 1, ch. 157).* *State (1) occurs in Metasuchia.* *State (2) describes the flattened morphology of tethysuchians.* 0. dermal bar that is either not columnal or transversely flattened 1. subdermal bar that is distinctly columnar and cylindrical or oval-shaped 2. subdermal bar that is distinctly columnar and transversely flattened
165	**Postorbital bar, composition of lateral surface:** *Gasparini et al. (2006, ch. 244); Andrade et al. (2011, ch. 199); Ristevski et al. (2018, ds 2, ch. 141); Smith et al. (in review, ds 1, ch. 145); Ősi et al. (2018, ds 1, ch. 158).* *State (1) is putative apomorphy of Thalattosuchia* 0. lateral surface formed by the postorbital and jugal 1. lateral surface formed by solely by the postorbital, with the jugal only exposed on the medial face of the bar
166	**Quadratojugal-postorbital, contact:** *Ortega et al. (2000, ch. 49); Nesbitt (2011, ch. 64); Young et al. (2016, ds 2, ch. 105); Ristevski et al. (2018, ds 2, ch. 142); Smith et al. (in review, ds 1, ch. 146); Ősi et al. (2018, ds 1, ch. 159).* *State (1) is a putative apomorphy of Crocodyliformes.* 0. absent 1. present
167	**Infratemporal fenestra (= laterotemporal fenestra), in lateral view:** *Young (2006, ch. 12); Wilkinson et al. (2008, ch. 32); Young & Andrade (2009, ch. 32); Young et al. (2011, ch. 32); Young et al. (2013a, ch. 73); Young et al. (2012, ch. 86); Young (2014, ch. 88); Young et al. (2016, ds 2, ch. 106); Ristevski et al. (2018, ds 2, ch. 143); Smith et al. (in review, ds 1, ch. 147); Ősi et al. (2018, ds 1, ch. 160).* 0. considerably longer in length than the orbit (greater than 25%) 1. equal/subequal in length than the orbit (± 10%) 2. shorter in length than the orbit (less than 25%)
168	**Quadratojugal, spine (= spina quadratojugalis):** *Brochu (1999, ch. 114); Young & Andrade (2009, ch. 133); Young et al. (2011, ch. 133); Young et al. (2013a, ch. 74); Andrade et al. (2011, ch. 167 + 170). Young et al. (2012, ch. 87); Young (2014, ch. 89); Young et al. (2016, ds 2, ch. 107); Ristevski et al. (2018, ds 2, ch. 144); Smith et al. (in review, ds 1, ch. 148); Ősi et al. (2018, ds 1, ch. 161).* 0. absent 1. either small or low crest 2. prominent

Palate and perichoanal structures (Ch. 169 – 191; 5.000% of characters)
[palate contribution of the dermatocranium facial series (= os præmaxillare and os maxillare), and dermatocranium palatal series (= ossa palatina, ossa pterygoidea, ossa ectopterygoidea and ossa vomeria)]

#	Description
169	**Premaxillae, presence of a subelliptic naso-oral fossa (= incisive foramen, = fossa premaxillaris) at medial contact of ventral rami:** *Brochu (1999, ch. 124 part); Andrade et al. (2011, ch. 66); Young et al. (2012, ch. 89 mod.); Young (2014, ch. 91 part); Young et al. (2016, ds 2, ch. 109 mod.); Ristevski et al. (2018, ds 2, ch. 145); Smith et al. (in review, ds 1, ch. 149); Ősi et al. (2018, ds 1, ch. 162).* *When the palate does not close completely, the passage will involve both premaxilla and maxilla, assuming a diamond-shaped profile, with edges straight to irregular, but never rounded and smooth. When the palate is incompletely closed, it is most likely that the vomer is also exposed at the opening; however, the vomer may not be preserved; or may be covered by sediment and not evident. The use of 'sub-elliptic' allows that simple openings on the palatal surface, considered as non-homologous to the naso-oral fossa, to be scored as (0).* 0. absent, premaxillae fully in contact medially along the palate 1. present as a discrete fossa or foramen, less than half the greatest width of premaxillae 2. large, more than half the greatest width of premaxillae
170	**Premaxillae, shape of naso-oral fenestra (= incisive foramen): (*)** *Young et al. (2016, ds 2, ch. 7 mod.); Ristevski et al. (2018, ds 2, ch. 146); Smith et al. (in review, ds 1, ch. 150); Ősi et al. (2018, ds 1, ch. 163).* *In Metriorhynchidae, state (1) occurs in* Torvoneustes, *Mr Passmore's specimen* + 'M.' hastifer. *This character is not applicable for taxa that lack the naso-oral fenestra.* 0. subcircular or longer than wide (but not an elongate oval) 1. elongate anteroposterior oval-shape (can be as long or longer than the premaxillary alveoli, but not as mediolaterally broad)
171	**Suborbital fenestrae, presence and size: (ORDERED)** *Andrade et al. (2011, ch. 206); Ristevski et al. (2018, ds 1, ch. 206); Smith et al. (in review, ds 2, ch. 206); Ősi et al. (2018, ds 1, ch. 164).* 0. absent 1. present, much smaller than orbits 2. present, subequal or larger than orbits
172	**Suborbital fenestrae, shape of anterior border: (*)** *Andrade & Bertini (2008, ch. 86); Andrade et al. (2011, ch. 207); Ristevski et al. (2018, ds 1, ch. 207); Smith et al. (in review, ds 2, ch. 207); Ősi et al. (2018, ds 1, ch. 165).* *The original scoring in Andrade & Bertini (2008) for* Malawisuchus *and* Candidodon *was state (1), but this could be due to taphonomic deformation, therefore both taxa should be scored as (?) until a detailed description is provided for each taxon. Nonetheless, state (1) is present in Thalattosuchia.* *This character is not applicable for taxa that lack suborbital fenestrae.* 0. rounded, smooth 1. in sharp angle, forming a notch, fissure-like
173	**Maxilla, palatal processes: (ORDERED)** *Nesbitt (2011, ch. 32); Ristevski et al. (2018, ds 2, ch. 147); Smith et al. (in review, ds 1, ch. 151); Ősi et al. (2018, ds 1, ch. 166).* *Character helps to quantify the development of the secondary palate.* *State (2) occurs in crocodylomorphs.* 0. do not meet at the midline 1. meet at the midline 2. meet at the midline and expand anteriorly and posteriorly
174	**Maxilla, posterior margin of palatal processes contact with the anterior margin of palatine anterior processes:** *Young et al. (2012, ch. 90 mod.); Young (2014, ch. 92 mod.); Young et al. (2016, ds 2, ch. 110 mod.); Ristevski et al. (2018, ds 2, ch. 148); Smith et al. (in review, ds 1, ch. 152); Ősi et al. (2018, ds 1, ch. 167).* *Character helps to quantify the development of the secondary palate.* *State (1) occurs in Mesoeucrocodylia.*

	Note, for Calsoyasuchus *we interpret the 'primary choanae' as maxillo-palatine fenestrae.* 0. the maxilla-palatine contact only along a margin medial to the alveolar row 1. the maxilla posterior palatal margin has an extensive contact with the palatine anterior palatal margin. This results in either the vomer being excluded from the palatal surface, or if maxillo-palatine fenestrae are present, the vomer is visible within. The maxillo-palatine contact forms a continuous surface as the two elements contact one another, or when maxillo-palatine fenestrae are present, the anterior-most region of the contact is interrupted.
175	**Palate canals, presence: (*)** *Andrade et al. (2011, ch. 220); Ristevski et al. (2018, ds 2, ch. 149); Smith et al. (in review, ds 1, ch. 153); Ősi et al. (2018, ds 1, ch. 168).* *State (1) is a putative apomorphy of Thalattosuchia.* *This character is not applicable for taxa that lack maxillary and palatine palatal processes which meet along the skull midline.* *Palate canals are a paired, parallel, elongated, tubular ducts connecting the internal nasal cavity to the oral cavity, through the palatines. The orientation is almost coincident with the horizontal plane and longitudinal axis, with very little deviation (0-5 degrees). The internal openings are located anterior to the internal end of the nasopharyngeal duct. The external openings are located at the anterior end of palatines and, because of its sub-horizontal orientation, they progress as paired shallow (but well-defined) gutter-like grooves through the palatine laminae of the maxillae, at least to mid-rostrum. In teleosauroids (the Chinese teleosauroid,* Steneosaurus leedsi, S. edwardsi, *specimens attributed to* Steneosaurus latifrons*) and basal metriorhynchoids (*Pelagosaurus typus *and* Eoneustes gaudryi*) these passages are located next to the medial line of the palate, very close to each other, while in Metriorhynchidae the grooves diverge anteriorly (e.g. see Andrews, 1913; Young et al. 2013). This anterior divergence is also seen in some well preserved teleosauroids (MTY pers. obs).* *It is unclear if these canals constitute passages for nerves, vessels, or gland ducts. In specimens which have experienced dorsoventral compression, and/or are highly broken, these canals can be very hard to discern.* 0. absent 1. present
176	**Palate longitudinal depressions, presence: (NEW)** *State (1) is a putative apomorphy of* Cricosaurus bambergensis*.* *Palate longitundinal depressions are paired, parallel and elongate depressions that are situated on the palatal surface of the palatines. Between the depressions, the palatines are reduced to a midline crest. Along the anterior margin of these depressions is a cluster of foramina.* *It is unclear if these canals constitute passages for nerves, vessels, or gland ducts. It is also unclear whether these depressions are related to the thalattosuchian palate canals, being a modification of the same soft-tissue morphology, or unrelated.* *This structure can be determind as palatine and not pterygoid (i.e. the internal choana) in origin, as the anterior margins are level to the end of the maxillary tooth row and the depressions themselves are ventral to the orbits. Thus, they are too anterior to be the internal choana.* 0. absent 1. present
177	**Palatine, anterior extent of the palatine relative to the maxillary tooth row:** *Young (2014, ch. 93); Young et al. (2016, ds 2, ch. 111); Ristevski et al. (2018, ds 2, ch. 150); Smith et al. (in review, ds 1, ch. 154); Ősi et al. (2018, ds 1, ch. 169).* *State (5) is a putative autapomorphy of* Plesiosuchus manselii. 0. palatine anterior margin terminates level to 20th maxillary alveoli, or more distal alveoli 1. palatine anterior margin terminates level to 15th to 19th maxillary alveoli 2. palatine anterior margin terminates level to 11th to 14th maxillary alveoli 3. palatine anterior margin terminates level to 8th to 10th maxillary alveoli 4. palatine anterior margin terminates level to 5th to 7th maxillary alveoli 5. palatine anterior margin terminates level to 4th maxillary alveoli, or more anterior alveoli

178	**Palatine, anterior margin has a mid-line anterior process:** *Wilkinson et al. (2008, ch. 6 part); Young & Andrade (2009, ch. 6 part); Young et al. (2011, ch. 6 part); Young et al. (2013a, ch. 76 part); Young et al. (2012, ch. 91); Young (2014, ch. 94); Young et al. (2016, ds 2, ch. 112); Ristevski et al. (2018, ds 2, ch. 151); Smith et al. (in review, ds 1, ch. 155); Ősi et al. (2018, ds 1, ch. 170).* 0. present 1. absent
179	**Palatine, mid-line anterior process shape, in palatal view: (*)** *Wilkinson et al. (2008, ch. 6 part); Young & Andrade (2009, ch. 6 part); Young et al. (2011, ch. 6 part); Young et al. (2013a, ch. 76 part); Young et al. (2012, ch. 92); Young (2014, ch. 95); Young et al. (2016, ds 2, ch. 113); Ristevski et al. (2018, ds 2, ch. 152); Smith et al. (in review, ds 1, ch. 156); Ősi et al. (2018, ds 1, ch. 171).* *This character is not applicable for taxa that lack mid-line palatine palatal processes.* 0. lateral margins of the mid-line anterior process converge: anteriorly orientated "V"-shape 1. lateral margins of the mid-line anterior process largely parallel: anteriorly orientated "U"-shape
180	**Palatine, anterior margin has two non-midline anterior processes:** *Wilkinson et al. (2008, ch. 6 part); Young & Andrade (2009, ch. 6 part); Young et al. (2011, ch. 6 part); Young et al. (2013a, ch. 76 part); Young et al. (2012, ch. 93); Young (2014, ch. 96); Young et al. (2016, ds 2, ch. 114); Ristevski et al. (2018, ds 2, ch. 153); Smith et al. (in review, ds 1, ch. 157); Ősi et al. (2018, ds 1, ch. 172).* *In Thalattosuchia, state (1) is a putative apomorphy of Metriorhynchinae.* *In* Montealtosuchus *and* Hamadasuchus *the mid-line anterior process has a concave anterior margin, creating two "non-midline" processes.* 0. absent 1. present
181	**Palatine, at the suborbital fenestrae the palatine anterior margin curves anterolaterally towards it, creating two "small processes" projecting laterally:** *Young & Andrade (2009, ch. 161); Young et al. (2011, ch. 161); Young et al. (2013a, ch. 77); Young et al. (2012, ch. 94); Young (2014, ch. 97); Young et al. (2016, ds 2, ch. 115); Ristevski et al. (2018, ds 2, ch. 154); Smith et al. (in review, ds 1, ch. 158); Ősi et al. (2018, ds 1, ch. 173).* *This morphology is variably observed in derived neosuchians and eusuchians.* 0. absent 1. present
182	**Palate, presence of palatal shelves of palatines, and their relation with the narial passage: (ORDERED)** *Clark (1994, ch. 37 part); Wilkinson et al. (2008, ch. 8 part); Young & Andrade (2009, ch. 8 part); Andrade et al. (2011, ch. 212); Young et al. (2011, ch. 8 part); Young et al. (2013a, ch. 78 part); Young et al. (2012, ch. 95 part); Pol et al. (2013, ch. 67 part); Young (2014, ch. 98 part); Young et al. (2016, ds 2, ch. 116 part); Leardi et al. (2017, ch. 67 part); Ristevski et al. (2018, ds 1, ch. 212; ds 2, ch. 155 part); Smith et al. (in review, ds 1, ch. 159 part; ds 2, ch. 212); Ősi et al. (2018, ds 1, ch. 174).* *Character helps to quantify the development of the secondary palate.* *State (2) occurs in Mesoeucrocodylia, and in some more basal taxa.* *Note that in state (2) the palatal laminae may not be in contact for taxa with extensive maxillopalatine fenestrae and elongate choanae (e.g.* Eutretauranosuchus*).* 0. palatal shelves of palatine absent, narial passage only bounded dorsally, by the pterygoid 1. narial passage at least partially bounded by palatal shelves of the palatine, laterally, creating the choanal grove 2. narial passage at least mostly bounded by palatal shelves of the palatine, laterally and ventrally, forming the nasopharyngeal duct
183	**Palatine, presence of a posterior extension to the choanae:** *Jouve et al. (2005b, ch. 4); Jouve et al. (2008, ch. 4); Hastings et al. (2010, ch. 61); Ristevski et al. (2018, ds 2, ch. 156); Smith et al. (in review, ds 1, ch. 160); Ősi et al. (2018, ds 1, ch. 175).*

	0. do not contact or only contact along the anterior margin 1. contact along the anterior and medial margins
184	**Palatine-pterygoid suture, lateral protrusions by palatine into the pterygoids:** *Young & Andrade (2009, ch. 132); Young et al. (2011, ch. 132); Young et al. (2013a, ch. 80); Young et al. (2012, ch. 97); Young (2014, ch. 100); Young et al. (2016, ds 2, ch. 118); Ristevski et al. (2018, ds 2, ch. 157); Smith et al. (in review, ds 1, ch. 161); Ősi et al. (2018, ds 1, ch. 176).* 0. absent 1. present
185	**Ectopterygoid, presence of broad contact with palatine ramus of maxilla:** *Ristevski et al. (2018, ds 2, ch. 158); Smith et al. (in review, ds 1, ch. 162); Ősi et al. (2018, ds 1, ch. 177).* *Character based on Brochu (1997, ch. 91 mod.); Andrade et al. (2011, ch. 253). Basal forms within Sphenosuchia will show no (or very limited) contact between ectopterygoid and maxilla (0). As* Fruitachampsa *has a jugal-ectopterygoid contact (Clark, 2011), here we find this character to be a putative apomorphy of Mesoeucrocodylia* +Hsisosuchus*, rather than Crocodyliformes as in Andrade et al. (2011). Note,* Hsisosuchus *is not in our matrix, but scores as (1) in Andrade et al. (2011)* *State (1) is putative apomorphy of Mesoeucrocodylia* + Hsisosuchus *(reversals in: French* Pholidosaurus*, and* Zoneait + *Metriorhynchidae – the ectopterygoid solely contacts the jugal).* *Note that in metriorhynchids the ectopterygoid is rarely preserved, and thus hard to score. It can be scored for* Metriorhynchus superciliosus *as it has what looks like the jugal-ectopterygoid articulation in NHMUK PV R 6860. However, the ectopterygoids are complete and in articulation in both* Zoneait *and* Maledictosuchus*.* 0. absent, ectopterygoid does not contact maxilla, or barely contacts its caudal end, medial to jugal 1. present
186	**Ectopterygoid, morphology of the distal ramus: (*)** *Andrade et al. (2011, ch. 256); Ristevski et al. (2018, ds 1, ch. 256); Smith et al. (in review, ds 2, ch. 256); Ősi et al. (2018, ds 1, ch. 178).* *Based on description by Pol & Apesteguia (2005: p. 8), where the subcylindrical profile of the distal ramus (1) was noted in* Araripesuchus buitreraensis*.* *The condition is shared at least by other* Araripesuchus*,* Montealtosuchus *and a few other basal notosuchians.* *This character is not applicable for taxa in which the ectopterygoid does not extend over the pterygoid wing.* 0. laminar, extending as a flattened sheet over the pterygoid wing 1. robust, extending as a rod over most of the pterygoid wing, with subcircular cross-section through most of its length
187	**Pterygoid flange, orientation (in palatal view):** *Young et al. (2011, ch. 186); Young et al. (2013a, ch. 81); Young et al. (2012, ch. 98); Young (2014, ch. 101); Young et al. (2016, ds 2, ch. 119); Ristevski et al. (2018, ds 2, ch. 159); Smith et al. (in review, ds 1, ch. 163); Ősi et al. (2018, ds 1, ch. 179).* 0. horizontal 1. largely horizontal, but with a distinct posterolateral orientation 2. strongly orientated posteriorly
188	**Choanae, participation of pterygoid in the choanal border: (*)** *Clark (1994, ch. 43 mod.); Brochu (1999, ch. 71 mod.); Jouve et al. (2005, ch. 4 mod.); Turner & Buckley (2008, ch. 43 mod.); Young & Andrade (2009, ch. 131 + 139 mod.); Andrade et al. (2011, ch. 242); Young et al. (2011, ch. 131 + 139 mod.); Young et al. (2013a, ch. 79 + 82 mod.); Young et al. (2012, ch. 96 + 99 mod.); Young (2014 ch. 99 + 102); Young et al. (2016, ds 2, ch. 117 + 120 mod.); Ristevski et al. (2018, ds 2, ch. 160); Smith et al. (in review, ds 1, ch. 164); Ősi et al. (2018, ds 1, ch. 180).* *Note that the palatines may be excluded from the choanal border either in states (2) and (3), but the eusuchian condition is only achieved in state (3). State (2) corresponds directly to state (1) of Jouve et al. (2005, ch. 4), apomorphic for* Elosuchus, Terminonaris, Pholidosaurus purbeckensis + *dyrosaurids.*

	Note that we do not consider Koumpiodontosuchus *or* Isisfordia *to have the eusuchian condition. Our interpretation for* Isisfordia *follows Turner & Pritchard (2015), and* Koumpiodontosuchus *has a similar morphology (MTY pers. obs.).* *This character is not applicable for taxa that lack the development of the secondary palate.* 0. pterygoid only bounds the posterior border of the choanae 1. pterygoid forms at least the posterior and lateral choanal borders 2. anterolateral rami of pterygoid embrace most of the choanae, but do not meet medially, at the anterior choanal border (either by the presence of palatine or ventral exposure and expansion of interchoanal septum) 3. anterolateral rami of pterygoid completely embrace the choanae, meeting medially at its anterior border (eusuchian choanae)
189	**Pterygoids, fusion posterior to choanae:** *Clark (1994, ch. 41); Andrade et al. (2011, ch. 258); Ristevski et al. (2018, ds 2, ch. 161); Smith et al. (in review, ds 1, ch. 165); Ősi et al. (2018, ds 1, ch. 181).* *State (1) is putative apomorphy of* Zosuchus *+ Mesoeucrocodylia.* 0. not fused 1. fused
190	**Choanal opening, in palatal view:** *Wilkinson et al. (2008, ch. 9 part); Young & Andrade (2009, ch. 9 part); Young et al. (2011, ch. 187); Young et al. (2013a, ch. 83); Young et al. (2012, ch. 100); Young (2014, ch. 103); Young et al. (2016, ch. 121); Ristevski et al. (2018, ds 2, ch. 162); Smith et al. (in review, ds 1, ch. 166); Ősi et al. (2018, ds 1, ch. 182).* *State (1) is observed in extant species.* 0. choanal opening orientated posteriorly, enclosed ventrally by the palatine and by either the pterygoid dorsally or the maxilla 1. choana opens into palate through a deep midline depression (choanal groove)
191	**Choana, anterior margin shape:** *Wilkinson et al. (2008, ch. 9 part); Young & Andrade (2009, ch. 9 part); Young et al. (2011, ch. 9); Young et al. (2013a, ch. 84); Young et al. (2012, ch. 101); Young (2014, ch. 104); Young et al. (2016, ds 2, ch. 122); Ristevski et al. (2018, ds 2, ch. 163); Smith et al. (in review, ds 1, ch. 167); Ősi et al. (2018, ds 1, ch. 183).* 0. semicircular or elliptical 1. 'V'-shaped with its base directed anteriorly 2. broad 'U'-shaped with its base directed anteriorly 3. 'W'-shaped with its base directed anteriorly

Occiptal (Ch. 192 – 206; 3.261% of characters)

[Partial chondrocranium = os supraoccipitale, ossa exoccipitalia + ossa opisthotica (= os otoccipitale)]

#	Description
192	**Occipital tuberosities:** *Jouve (2005, ch. 1 mod.), Jouve et al. (2005b, ch. 3 mod.), Jouve et al. (2008, ch. 3 mod.), Hastings et al. (2010, ch. 53 mod.); Young et al. (2011, ch. 188); Young et al. (2013a, ch. 85); Young et al. (2012, ch. 102 mod.); Young (2014, ch. 105 mod.); Young et al. (2016, ds 2, ch. 123 mod.); Ristevski et al. (2018, ds 2, ch. 164); Smith et al. (in review, ds 1, ch. 168); Ősi et al. (2018, ds 1, ch. 184).* *State (1) occurs in teleosauroids, basal dyrosaurids and in the pholidosaurids* Sarcosuchus *and* Chalawan. *State (2) occurs in most dyrosaurids and the teleosauroid* Steneosaurus heberti. 0. absent 1. small and reduced 2. large and well-developed
193	**Supraoccipital, presence:** *Leardi et al. (2017, ch. 97); Ősi et al. (2018, ds 1, ch. 185).* *State (1) occurs in Crocodylomorpha.* 0. fused with the exoccipital 1. present as a separate ossification
194	**Exoccipitals, presence of medial contact between both elements:**

	Clark (1994, ch. 62); Ortega et al. (2000, ch. 63); Gower (2002, ch. 19 mod.); Andrade et al. (2011, ch. 270); Nesbitt (2011, ch. 126); Young et al. (2013a, ch. 86); Young et al. (2012, ch. 103); Young (2014, ch. 106); Tennant et al. (2016, ch. 198); Young et al. (2016, ds 2, ch. 124); Ristevski et al. (2018, ds 2, ch. 166); Smith et al. (in review, ds 1, ch. 170); Ősi et al. (2018, ds 1, ch. 187). *Can also be defined as the participation of supraoccipital in the foramen magnum.* 0. do not meet in midline 1. meet on the midline, dorsal to the basioccipital, excluding the supraoccipital from the foramen magnum
195	**Paroccipital processes of the opisthotic, orientation in occipital view:** *Wilkinson et al. (2008, ch. 7); Young & Andrade (2009, ch. 7); Young et al. (2011, ch. 7); Young et al. (2013a, ch. 87); Young et al. (2012, ch. 104); Young (2014, ch. 107); Young et al. (2016, ds 2, ch. 125); Ristevski et al. (2018, ds 2, ch. 167); Smith et al. (in review, ds 1, ch. 171); Ősi et al. (2018, ds 1, ch. 188).* *State (1) is a putative apomorphy of Rhacheosaurini.* *State (2) is a putative apomorphy of Geosaurinae.* *State (3) is a putative apomorphy of Dyrosauridae* + Pholidosaurus purbeckensis, *and also for* 'Dakosaurus' lissocephalus 0. horizontal 1. dorsolaterally orientated, at a 45 degree angle 2. ventral-edge horizontal, then terminal third sharply inclined dorsolaterally at a 45 degree angle 3. ventrally arched
196	**Paroccipital processes of the opisthotic, large ventrolateral region (i.e. the distal lower border is convex and bulges ventrally):** *Young & Andrade (2009, ch. 116); Young et al. (2011, ch. 116); Young et al. (2013a, ch. 88); Young et al. (2012, ch. 105); Young (2014, ch. 108); Young et al. (2016, ds 2, ch. 126); Ristevski et al. (2018, ds 2, ch. 168); Smith et al. (in review, ds 1, ch. 172); Ősi et al. (2018, ds 1, ch. 189).* *State (1) occurs in Crocodyliformes.* 0. present 1. absent
197	**Paroccipital process, overlap by the squamosal:** *Young & Andrade (2009, ch. 119); Young et al. (2011, ch. 119); Young et al. (2013a, ch. 89); Young et al. (2012, ch. 106); Young (2014, ch. 109); Young et al. (2016, ds 2, ch. 127); Ristevski et al. (2018, ds 2, ch. 169); Smith et al. (in review, ds 1, ch. 173); Ősi et al. (2018, ds 1, ch. 190).* 0. small: the squamosal does not extend more posteriorly than the paroccipital process 1. large: it extends further posteriorly than the paroccipital process
198	**Foramen for cranial nerve XII (hypoglossal), position on occipit:** *Wilkinson et al. (2008, ch. 10); Young & Andrade (2009, ch. 10); Young et al. (2011, ch. 10); Young et al. (2013a, ch. 90); Young et al. (2012, ch. 107); Young (2014, ch. 110); Young et al. (2016, ds 2, ch. 129); Ristevski et al. (2018, ds 2, ch. 170); Smith et al. (in review, ds 1, ch. 174); Ősi et al. (2018, ds 1, ch. 191).* 0. above the occipital condyle in line with the foramen magnum 1. below the foramen magnum
199	**Foramen for cranial nerve XII (hypoglossal), sits in the dorsomedial corner of 'occipital fossae' – concave depressions on the exoccipital on either side of the skull midline:** *Ristevski et al. (2018, ds 2, ch. 171); Smith et al. (in review, ds 1, ch. 175); Ősi et al. (2018, ds 1, ch. 192).* *State (1) occurs in* Torvoneustes. 0. absent 1. present
200	**Foramen for the cerebral carotid artery, external margin of the foramen is raised relative to the posterior face of the basioccipital, forming a sub-rectangular shape:** *Ristevski et al. (2018, ds 2, ch. 172); Smith et al. (in review, ds 1, ch. 176); Ősi et al. (2018, ds 1, ch. 193).* *State (1) occurs in* Torvoneustes.

	0. no 1. yes
201	**Foramen for the cerebral carotid artery, size:** *Wilkinson et al. (2008, ch. 11); Young & Andrade (2009, ch. 11); Young et al. (2011, ch. 11); Young et al. (2013a, ch. 91); Young et al. (2012, ch. 108); Young (2014, ch. 111); Young et al. (2016, ds 2, ch. 130); Ristevski et al. (2018, ds 2, ch. 173); Smith et al. (in review, ds 1, ch. 177); Ősi et al. (2018, ds 1, ch. 194).* *State (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* 0. similar in size to the openings for cranial nerves IX–XI 1. extremely enlarged
202	**Exoccipital, presence of descending flange ventral to subcapsular process:** *Clark (1994, ch. 58); Andrade et al. (2011, ch. 273); Ristevski et al. (2018, ds 2, ch. 174); Smith et al. (in review, ds 1, ch. 178); Ősi et al. (2018, ds 1, ch. 195).* *State (1) is putative apomorphy of protosuchids, but also present at least in* Araripesuchus tsangatsangana*.* 0. absent 1. present, laterally concave
203	**Exoccipital, extent of contact with the quadrate:** *Clark (1994, ch. 48 mod. + 51); Andrade et al. (2011, ch. 274); Ristevski et al. (2018, ds 2, ch. 175); Smith et al. (in review, ds 1, ch. 179); Ősi et al. (2018, ds 1, ch. 196).* *Andrade et al. (2011) merged characters 48 and 51 of Clark (1994), into one ordered series, as both refer to the contact between exoccipitals and quadrate. Following the present format, state (1) is a putative apomorphy of Gobiosuchidae + Mesoeucrocodylia.* 0. absent or narrow 1. broad contact present, stabilising the quadrate
204	**Exoccipital, presence of ventrolateral contact with the ventromedial part of quadrate:** *Clark (1994, ch. 51 mod.); Andrade et al. (2011, ch. 275); Ristevski et al. (2018, ds 1, ch. 275); Smith et al. (in review, ds 2, ch. 275); Ősi et al. (2018, ds 1, ch. 197).* *Focus of character (51) modified from quadrate to exoccipital, to make evident its relation with character 48 (original numbers of Clark, 1994). Note that both characters may be fused into one ordered series, as they refer to the contact between both elements.* *Following the present format, (1) is putative apomorphy of* Junngarsuchus + *Crocodyliformes.* 0. absent, quadrate does not contact exoccipital 1. present, exoccipital and quadrate enclosing carotid artery and forming passage for cranial nerves IX-XI
205	**Exoccipital, participation in the occipital condyle:** *Jouve (2004, ch. 96 mod.); Jouve et al. (2005b, ch. 5 mod.); Jouve et al. (2006, ch. 104 mod.); Jouve et al. (2008, ch. 5 mod.); Hastings et al. (2010, ch. 52 mod.); Ristevski et al. (2018, ds 2, ch. 176); Smith et al. (in review, ds 1, ch. 180); Ősi et al. (2018, ds 1, ch. 198).* *This scores the large contribution of the otocciptials to the occipital condyle seen in dyrosaurids, where the otoccipitals broadly contact the lateral margins of the condyle.* 0. slight to moderate 1. large, such that only a thin strip of the basioccipital is visible between the exoccipitals on the dorsal surface of the occipital condyle
206	**Occipital surface ventral to occipital condyle:** *Young & Andrade (2009, ch. 143); Young et al. (2011, ch. 143); Young et al. (2013a, ch. 92); Young et al. (2012, ch. 109); Young (2014, ch. 112); Young et al. (2016, ds 2, ch. 131); Ristevski et al. (2018, ds 2, ch. 177); Smith et al. (in review, ds 1, ch. 181); Ősi et al. (2018, ds 1, ch. 199).* *State (1) is a putative apomorphy of Crocodylia.* 0. slopes anteroventrally 1. sub-parallel or parallel to the transverse plane

Braincase, basicranium and suspensorium (Ch. 207 – 232; 5.652% of characters)
[Partial chondrocranium (= ossa laterosphenoidea, ossa prootica, os basioccipitale, os basisphenoideum); partial splanchnocranium (= ossa quadrata); pneumatic foramina; cranioquadrate canal]

#	Description
207	**Trigeminal fossa (= fossa for cranial nerve V), development on quadrate and laterosphenoid:** *Young et al. (2013a, ch. 93); Young et al. (2012, ch. 110); Young (2014, ch. 113); Young et al. (2016, ds 2, ch. 132); Ristevski et al. (2018, ds 2, ch. 178); Smith et al. (in review, ds 1, ch. 182); Ősi et al. (2018, ds 1, ch. 200).* *Character based on the discovery by Fernández et al. (2011).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. developed anteriorly and posteriorly to the trigeminal fenestra (i.e. fossa present on both laterosphenoid and quadrate) 1. fossa is mainly developed posteriorly to the fenestra (i.e. fossa present on quadrate)
208	**Laterosphenoids, sutures with parietal:** *Hastings et al. (2010, ch. 63 mod.); Ristevski et al. (2018, ds 2, ch. 179); Smith et al. (in review, ds 1, ch. 183); Ősi et al. (2018, ds 1, ch. 201).* 0. parallel to the skull table 1. descends posteriorly, relative to the skull table
209	**Laterosphenoids, fossae for the *m. pseudotemporalis superficialis*:** *Young et al. (2013a, ch. 94 mod.); Young et al. (2012, ch. 111 mod.); Young (2014, ch. 114 mod.); Young et al. (2016, ds 2, ch. 133 mod.); Ristevski et al. (2018, ds 2, ch. 180); Smith et al. (in review, ds 1, ch. 184); Ősi et al. (2018, ds 1, ch. 202).* *Character based upon data from Holliday & Witmer (2009) and Fernández et al. (2011).* *State (1) is a putative apomorphy of Metasuchia.* 0. presence of a *pseudotemporalis* fossa on the dorsal surface of the laterosphenoid, and/or continuing on to the frontal 1. either an absence of the pseudotemporalis fossa on the dorsal surface of the laterosphenoid (i.e. only the *m. adductor mandibulae externus profundus* is within the supratemporal fenestra), or scorable by the presence of the fossa on the posteroventral surface of the laterosphenoid (the “subfenestral position”)
210	**Parasphenoid ridge/rostrum (?), in palatal view:** *Wilkinson et al. (2008, ch. 4); Young & Andrade (2009, ch. 4); Young et al. (2011, ch. 4); Young et al. (2013a, ch. 95); Young et al. (2012, ch. 112); Young (2014, ch. 115); Young et al. (2016, ds 2, ch. 134); Ristevski et al. (2018, ds 2, ch. 181); Smith et al. (in review, ds 1, ch. 185); Ősi et al. (2018, ds 1, ch. 203).* *The homology of this ridge is unknown. Andrews (1913) considered the midline pterygoid ridge to be the parasphenoid. However, the pterygoids are poorly known for metriorhynchids, and we cannot discount this as a purely pterygoid structure. Until this structure has undergone CT scanning we will provisionally use the term parasphenoid.* 0. not visible 1. forms a midline ridge along the pterygoids
211	**Basisphenoid, paired ridges located medially on the ventral surface:** *Young & Andrade (2009, ch. 83); Young et al. (2011, ch. 83); Young et al. (2013a, ch. 96); Young et al. (2012, ch. 113); Young (2014, ch. 116); Young et al. (2016, ds 2, ch. 135); Ristevski et al. (2018, ds 2, ch. 182); Smith et al. (in review, ds 1, ch. 186); Ősi et al. (2018, ds 1, ch. 204).* *State (1) occurs in Teleosauroidea.* 0. absent 1. present
212	**Basisphenoid, ventral exposure in adults and young individuals, but not immature or hatchlings: (ORDERED)** *Clark (1994, ch. 55 rev. + 56 rev.); Ortega et al. (2000, ch. 68 mod.); Young & Andrade (2009, ch. 87 mod.); Andrade et al. (2011, ch. 286 mod.); Young et al.*

	(2011, ch. 87 mod.); Young et al. (2013a, ch. 97 mod.); Young et al. (2012, ch. 114 mod.); Young (2014, ch. 117 mod.); Young et al. (2016, ds 2, ch. 136 mod.); Ristevski et al. (2018, ds 2, ch. 183); Smith et al. (in review, ds 1, ch. 187); Ősi et al. (2018, ds 1, ch. 205). *Original characters by Clark (1994, ch. 55-56) actually reflect the size of basisphenoid and here were combined into one character by Andrade et al. (2011). Note disagreement in the scorings from previous works, e.g., Clark (1994) considered thalattosuchians as (0) and Turner & Buckley (2008) considers them as (1); Turner & Buckley (2008) considers* Mahajangasuchus *as (2), whereas here it is considered as (1). Most authors consider "Sphenosuchians" as (1), but the basisphenoid is well exposed at least in* Gracilisuchus*,* Sphenosuchus *and possibly in* Pseudhesperosuchus *(see Bonaparte, 1971; Romer, 1972; Walker, 1990). Further scorings by Turner & Buckley (2008).* *Note Ristevsski et al. (2018, ds 2) re-ordered the character from Andrade et al. (2011). State (2) is now (0), and state (0) is now (2). State (1) is unaffected.* 0. ample surface exposed ventrally, basisphenoid at least as long as the basioccipital, or longer 1. well-exposed, although basisphenoid surface clearly smaller than basioccipital surface 2. extremely reduced surface, exposed as a transversal slit, almost obliterated ventrally by the basioccipital and the pterygoids
213	**Basisphenoid, exposure anterior to the quadrates in palatal view:** *Wilkinson et al. (2008, ch. 5 mod.); Young & Andrade (2009, ch. 5 mod.); Young et al. (2011, ch. 5 mod.); Young et al. (2013a, ch. 98); Young et al. (2012, ch. 115); Young (2014, ch. 118); Young et al. (2016, ds 2, ch. 137); Ristevski et al. (2018, ds 2, ch. 184); Smith et al. (in review, ds 1, ch. 188); Ősi et al. (2018, ds 1, ch. 206).* *State (1) is a putative apomorphy of a teleosaurid subclade. This character state is caused by the posterior expansion of the pterygoid's posterior margin, so that the anterior portion of the quadrates is obscured, as are the lateral margins of the basisphenoid. However, there is a distinct basisphenoid 'rostrum' that in some taxa continue to bifurcate the ptergoids anteriorly. This morphology is not observed in* Teleosaurus cadomensis*, the skull referred to* Peipehsuchus teleorhinus, Steneosaurus brevior, Pelagosaurus typus *or Metriorhynchidae.* 0. basisphenoid terminates approximately level to the anterior extent of the quadrates 1. basisphenoid 'rostrum'/cultriform process exposed along the palatal surface anterior to the quadrates, continuing to bifurcate the pterygoids
214	**Basisphenoid rostrum (= cultriform process):** *Jouve (2005, ch. 2), Jouve et al. (2005b, ch. 7), Jouve et al. (2008, ch. 7), Hastings et al. (2010, ch. 54); Ristevski et al. (2018, ds 2, ch. 185); Smith et al. (in review, ds 1, ch. 189); Ősi et al. (2018, ds 1, ch. 207).* *State (1) is observed in some derived dyrosaurids. This character is not homologous with the anterior projection of the basisphenoid oberserved in teleosaurids. Here, the basisphenoid projects anteriorly between the pterygoids and laterosphenoids, rather than bifurcating the former.* 0. short 1. extremely long anteriorly
215	**Basisphenoid, exposure ventral to the basioccipital at maturity in occipital aspect:** *Young & Andrade (2009, ch. 144); Young et al. (2011, ch. 144); Young et al. (2013a, ch. 99); Young et al. (2012, ch. 116); Young (2014, ch. 119); Young et al. (2016, ds 2, ch. 138); Ristevski et al. (2018, ds 2, ch. 186); Smith et al. (in review, ds 1, ch. 190); Ősi et al. (2018, ds 1, ch. 208).* *State (1) is a putative apomorphy of Eusuchia.* 0. absent, pterygoid dorsoventrally short ventral to median pharyngeal opening (= "medial Eustachain foramen") 1. present, pterygoid dorsoventrally tall ventral to median pharyngeal opening
216	**Basisphenoid, development of basipterygoid processes:** *Clark (1994, ch. 54 rev.); Andrade et al. (2011, ch. 289 mod.); Ristevski et al. (2018, ds 2, ch. 187); Smith et al. (in review, ds 1, ch. 191); Ősi et al. (2018, ds 1, ch. 209).* *State (1) occurs in Crocodyliformes.*

	0. prominent, forming a movable joint with pterygoid, and with basisphenoid joint suturally closed 1. small or absent
217	**Basioccipital, single wide rugosity oriented anteroposteriorly along the midline of the ventral surface of the occipital condyle:** *Hastings et al. (2010, ch. 55 mod.); Ristevski et al. (2018, ds 2, ch. 188); Smith et al. (in review, ds 1, ch. 192); Ősi et al. (2018, ds 1, ch. 210).* 0. absent 1. present
218	**Basioccipial, presence of tuberosities (= basal tubera):** *Clark (1994, ch. 57); Lauprasert et al. (2007, ch. 46); Young & Andrade (2009, ch. 151); Andrade et al. (2011, ch. 288); Young et al. (2011, ch. 151); Young et al. (2013a, ch. 100); Young et al. (2012, ch. 117); Young (2014, ch. 120); Young et al. (2016, ds 2, ch. 139); Ristevski et al. (2018, ds 2, ch. 189); Smith et al. (in review, ds 1, ch. 193); Ősi et al. (2018, ds 1, ch. 211).* *State (1) occurs in longirostrine taxa.* 0. reduced 1. large and pendulous
219	**Basioccipital tuberosities, in ventral view:** *Hastings et al. (2010, ch. 56 mod.); Ristevski et al. (2018, ds 2, ch. 190); Smith et al. (in review, ds 1, ch. 194); Ősi et al. (2018, ds 1, ch. 212).* 0. oblong-shaped 1. 'V'-shaped or tear-drop shaped
220	**Paired grooves along ventral surface, extending from base of the occipital condyle to the basioccipital tuberosities:** *Hastings et al. (2010, ch. 57 mod.); Ristevski et al. (2018, ds 2, ch. 191); Smith et al. (in review, ds 1, ch. 195); Ősi et al. (2018, ds 1, ch. 213).* 0. absent 1. present
221	**Ventral part of the basioccipital:** *Jouve et al. (2005b, ch. 13), Jouve et al. (2008, ch. 13), Hastings et al. (2010, ch. 59); Ristevski et al. (2018, ds 2, ch. 192); Smith et al. (in review, ds 1, ch. 196); Ősi et al. (2018, ds 1, ch. 214).* 0. vertical, largely visible in occipital view 1. strongly inclined, weakly visible in occipital view
222	**Quadrate, prominent crest on dorsal surface of distal quadrate extending proximally to lateral extent of quadrate–exoccipital contact:** *Young & Andrade (2009, ch. 101); Young et al. (2011, ch. 101); Young et al. (2013a, ch. 101); Young et al. (2012, ch. 118); Young (2014, ch. 121); Young et al. (2016, ds 2, ch. 140); Ristevski et al. (2018, ds 2, ch. 193); Smith et al. (in review, ds 1, ch. 197); Ősi et al. (2018, ds 1, ch. 215).* *State (1) occurs in Metasuchia (with reversals, such as in Crocodylia).* 0. absent 1. present
223	**Quadrate, contact with the proötics:** *Clark et al. (2000, ch. 14); Clark & Sues (2002, ch. 15); Sues et al. (2003, ch. 15); Clark et al. (2004, ch. 15); Nesbitt (2011, ch. 76); Pol et al. (2013, ch. 15); Young et al. (2016, ds 2, ch. 141); Leardi et al. (2017, ch. 15); Ristevski et al. (in review, ds 2, ch. 194); Smith et al. (2018, ds 1, ch. 198); Ősi et al. (2018, ds 1, ch. 216).* *State (1) is a putative apomorphy of Crocodylomorpha.* 0. does not contact the proötic 1. contacts the proötic
224	**Quadrate, articulation of dorsal head contact:** *Clark (1994, ch. 47); Young & Andrade (2009, ch. 102 mod.); Andrade et al. (2011, ch. 298); Young et al. (2011, ch. 102 mod.); Young et al. (2013a, ch. 102 mod.); Young et al. (2012, ch. 119 mod.); Young (2014, ch. 122 mod.); Young et al. (2016, ds 2, ch. 142); Ristevski et al. (2018, ds 2, ch. 195); Smith et al. (in review, ds 1, ch. 199); Ősi et al. (2018, ds 1, ch. 217).* *State (1) is a putative apomorphy of* Junggarsuchus + *Crocodyliformes.* 0. squamosal and exoccipital/opisthotic/otoccipital (can have medial contact with proötics and laterosphenoids)

	1. proötic and laterosphenoid
225	**Quadrate, posterior margin:** *Nesbitt (2011, ch. 77); Young et al. (2016, ds 2, ch. 143); Ristevski et al. (2018, ds 2, ch. 196); Smith et al. (in review, ds 1, ch. 200); Ősi et al. (2018, ds 1, ch. 218).* *State (1) is a putative apomorphy of Metasuchia – note that the ventral/anteroventral margins of the distal ends of the paroccipital processes have a strong sutural contact with the quadrates.* 0. does not have a sutural contact with the paroccipital process of the opisthotic, or the anterior margin of the paroccipital process has a simple contact with the posterior margin of the quadrate 1. has a robust sutural contact with the paroccipital process of the opisthotic
226	**Quadrate, anteroventral process suturing to the braincase:** *Young et al. (2013a, ch. 103 mod.); Young et al. (2012, ch. 120 mod.); Young (2014, ch. 123 mod.); Young et al. (2016, ds 2, ch. 144 mod.); Ristevski et al. (2018, ds 2, ch. 197); Smith et al. (in review, ds 1, ch. 201); Ősi et al. (2018, ds 1, ch. 219).* *The scores for the contact of the anteroventral process (referred to as the 'orbital' and 'pterygoid' processes by different authors).* *State (2) represents the 'quadrate incompletely sutured to the braincase' statement in Holliday & Witmer (2009), Jouve (2009) and Fernández et al. (2011).* *The current version of this character aims to quantify two trends: 1) the contact between the quadrate and the laterosphenoid (as part of the stabilisation of the crocodylomorph skull), and 2) the thalattosuchian modification of this trend. In Thalattosuchia, it appears as though the anteromedial region of this process no longer articulates with the lateral surface of the neurocranium, but it is still elongated enough to have, and seems to sit lateral to the laterosphenoid. Perhaps suggesting a soft-tissue contact.* *State (1) occurs in Crocodyliformes.* *State (2) occurs in Thalattosuchia.* 0. this process contacts the pterygoid, but little to no contact with the neurocranium 1. this process has extensive contact with the laterosphenoid, basisphenoid and pterygoid (i.e. stabilises the splanchnocranium with the palate and neurocranium) 2. this process is free of bony attachment along its anteromedial surface, but ventrally contacts the pterygoid. Process likely has a posteromedial contact with the basisphenoid, but is free of contact with the laterosphenoid
227	**Quadrate, distal articular surface separated into two condyles:** *Young (2014, ch. 126); Young et al. (2016, ds 2, ch. 147); Ristevski et al. (2018, ds 2, ch. 200); Smith et al. (in review, ds 1, ch. 204); Ősi et al. (2018, ds 1, ch. 222).* *State (1) is a putative apomorphy of Plesiosuchina.* *Character can be scored if the articular is preserved, and no ridge that supports the intercondylar sulcus is present.* 0. yes 1. no
228	**Quadrate-quadratojugal, quadratojugal contributes to the upper jaw joint along with the quadrate (i.e. helps to form the lateral hemicondyle):** *Jouve et al. (2005b, ch. 19 mod.); Jouve et al. (2008, ch. 19 mod.); Hastings et al. (2010, ch. 60 mod.); Ristevski et al. (2018, ds 2, ch. 201); Smith et al. (in review, ds 1, ch. 205); Ősi et al. (2018, ds 1, ch. 223).* 0. lateral hemicondyle soley formed by the quadrate 1. lateral hemicondyle has a quadratojugal contribution
229	**Fossa for the tympanic membrane, anterior extension:** *Ristevski et al. (2018, ds 2, ch. 202); Smith et al. (in review, ds 1, ch. 206); Ősi et al. (2018, ds 1, ch. 224).* *State (1) occurs in Notosuchia and Sebecia.* *State (2) occurs in Neosuchia.* 0. limited to the squamosal 1. reaches the posterior margin of the postorbital 2. broadly exposed on the postorbital (covering the anterolateral margin) 3. crosses the postorbital and reaches the orbit
230	**Cranioquadrate canal, contact between the quadrate and exoccipital around the opening: (ORDERED)**

	Clark (1994, ch. 49 mod.); Andrade et al. (2011, ch. 306 mod. + ch. 308 mod.); Ristevski et al. (2018, ds 2, ch. 203); Smith et al. (in review, ds 1, ch. 207); Ősi et al. (2018, ds 1, ch. 225). *Cranioquadrate canal (=quadratosquamosootoccipitalis, in Salisbury et al., 1999; or =quadratosquamosoexoccipitalis, in Delfino et al., 2008).* *State (1) occurs in Hallopodidae* (*e.g.* Almadasuchus) *and Mesoeucrocodylia.* *In derived forms the squamosal will also help enclose the cranioquadrate canal.* *Contact between quadrate and exoccipital is extensive (2) in all crown crocodylians, but in all stem metasuchians this contact is feeble (1).* 0. absent (and the quadrate and exoccipital do not meet to enclose the cranioquadrate canal) 1. lateral contact between the quadrate and exoccipital is feeble, but these bones do meet to enclose the cranioquadrate canal 2. lateral contact between the quadrate and exoccipital is broad, and these bones do meet to enclose the cranioquadrate canal
231	**Cranioquadrate canal, bones enclosing:** *Ristevski et al. (2018, ds 2, ch. 204); Smith et al. (in review, ds 1, ch. 208); Ősi et al. (2018, ds 1, ch. 226).* *Scores for a similar morphology as Andrade et al. (2011, ch. 307), but with distinct differences.* *Cranioquadrate canal does not imply in the presence of a passage, and therefore may be opened laterally. The canal is only considered absent (0) in basal crocodylomorphs and basal crocodyliformes.* *Note at present state (0) here correlates with the state (0) in character quantifying the contact between the quadrate and exoccipital around the cranioquadrate canal. However, here a taxon with an enclosed cranioquadrate canal which does not have a squamosal participation would be scored as (0).* *State (1) occurs in Thalattosuchia.* *State (2) is common among goniopholidids and pholidosaurids.* *State (3) occurs in Metasuchia, but with some losses (especially in Neosuchia).* 0. quadrate, squamosal and exoccipital do not enclose the cranioquadrate canal along its length 1. squamosal laterally encloses the cranioquadrate canal, the quadrate ventrally, and the exoccipital posteriorly, medially and partly ventrally encloses the canal. This results in the canal opening laterally and/or posterolaterally 2. quadrate and squamosal do not laterally enclose the cranioquadrate canal, and it is laterally exposed but still exits on the occipital surface. *This looks to be a modification of state (3), where there is no ossified lateral enclosure, resulting in the 'open morphotype'*. 3. quadrate and squamosal laterally enclose the cranioquadrate canal, and the exoccipital helps enclose it dorsally. This results in the canal opening on the occipital surface
232	**Cranioquadrate canal, presence of a squamosal descending process separating the cranioquadrate canal from the external auditory meatus:** *Ristevski et al. (2018, ds 2, ch. 205); Smith et al. (in review, ds 1, ch. 209); Ősi et al. (2018, ds 1, ch. 227).* *State (1) occurs in thalattosuchians. Note that the* Teleosaurus cadomensis *specimen figured by Jouve (2009) had a broken squamosal descending lamina, and that the skull had been acid prepared. Here it is scored as (1).* Pelagosaurus typus *is also scored as (1), as the skull NHMUK PV OR 32599 is also acid prepared and many of the thin laminae are broken.* 0. absent, no clear separation of these structures 1. present, the cranioquadrate canal and the external auditory meatus are distinct openings, sharing a common wall (squamosal descending process)

Mandibular geometry (Ch. 233 – 240; 1.739% of characters)

#	Description
233	**Mandible geometry, relative positions of the dentary tooth-row and coronid process, and development of dorsal curvature of the posterior-end of the mandible:**

	Young et al. (2011, ch. 167); Young et al. (2013a, ch. 109); Young et al. (2012, ch. 127); Young (2014, ch. 131); Young et al. (2016, ds 2, ch. 153); Ristevski et al. (2018, ds 2, ch. 207); Smith et al. (in review, ds 1, ch. 211); Ősi et al. (2018, ds 1, ch. 229). *State (1) is a putative apomorphy of Metriorhynchidae.* *Quantifies the incipient increase of gape at the base of Metriorhynchidae.* 0. gentle curvature in the dorsal margin of the mandible, from the coronoid process to the end of the tooth-row 1. strong curvature, raising the coronoid process considerably above the tooth-row
234	**Mandible geometry, relative positions of coronoid process, retroarticular process and glenoid fossa:** *Young et al. (2011, ch. 168); Young et al. (2013a, ch. 110); Young et al. (2012, ch. 128); Young (2014, ch. 132); Young et al. (2016, ds 2, ch. 154); Ristevski et al. (2018, ds 2, ch. 208); Smith et al. (in review, ds 1, ch. 212); Ősi et al. (2018, ds 1, ch. 230).* *State (1) is a putative apomorphy of Geosaurini.* *This character quantifies the greater increase in gape associated with macrophagous geosaurines.* 0. coronoid process level to both the retroarticular process and glenoid fossa 1. coronoid process ventral to both the retroarticular process and glenoid fossa
235	**Mandibular rami, presence of a sharp dorsal inclination:** *Ristevski et al. (2018, ds 2, ch. 209); Smith et al. (in review, ds 1, ch. 213); Ősi et al. (2018, ds 1, ch. 231).* *State (1) is a putative apomorphy of Plesiosuchina.* 0. absent 1. present - immediately posterior to the mandibular symphysis the mandible sharply rises dorsally such that the ventral margin of the dentary (along with angular) is dorsally deflected (resulting in a distinct 'kink' along the mandibular ventral margin)
236	**Mandible, orientation of hemimandibles at their medial contact:** *Andrade et al. (2011, ch. 320); Ristevski et al. (2018, ds 1, ch. 320); Smith et al. (in review, ds 2, ch. 320); Ősi et al. (2018, ds 1, ch. 232).* 0. evidently acute angle, hemimandibles meet at approximately 45 degrees of each other, or less 1. broad angle, hemimandibles meet at approximately 70 degrees of each other, or more
237	**Mandible, morphology of distal rami in dorsal/ventral views:** *Andrade et al. (2011, ch. 321); Ristevski et al. (2018, ds 2, ch. 210); Smith et al. (in review, ds 1, ch. 214); Ősi et al. (2018, ds 1, ch. 233).* *Note that the broad-Y shape in (1) is not the result of elongation of the symphysis (which is present, but not exclusively in these forms), but by the arched distal rami, meeting at mid-mandible.* *State (1) is putative apomorphy of Notosuchidae + Sphagesauridae.* 0. distal rami mostly straight or poorly curved 1. distal rami strongly curved medially at mid-mandible, giving the mandible a broad-Y shape
238	**Mandible, ventral border at angular, in lateral view: (ORDERED)** *Andrade et al. (2011, ch. 322); Ristevski et al. (2018, ds 1, ch. 322); Smith et al. (in review, ds 2, ch. 322); Ősi et al. (2018, ds 1, ch. 234).* *This character, created by Andrade et al. (2011), is potentially co-dependent with Pol et al. (2012, ch. 280), which is not included here (see also Turner & Buckley 2008, ch. 280)* *State (0) is based on descriptions by Woodward (1896), Price (1945) and Andrade & Bertini (2008b). State (2) is originally based on descriptions by Hooley (1907), Schwarz (2002) and Ősi et al. (2007).* 0. angular straight and mostly horizontal, or poorly curved, from the anterior to the posterior end 1. angular evidently (but gently) curved 2. angular abruptly curved, always below glenoid fossa, with mid-posterior sections of angular sub-vertical, facing posteriorly
239	**Mandible, morphology of ventral margin, in lateral view:**

	Andrade et al. (2011, ch. 323); Ristevski et al. (2018, ds 1, ch. 323); Smith et al. (in review, ds 2, ch. 323); Ősi et al. (2018, ds 1, ch. 235). *The triple contact between dentary, angular and surangular can be taken as reference, if mandibular fenestra is absent* 0. mandible is curved ventrally, with maximum curvature at anterior section of angular, below the mandibular fenestra (when present), or not curved at all 1. mandible is curved posteroventrally, with maximum curvature at posterior section of angular, below (or almost below) the mandibular glenoid fossa, usually posterior to mandibular fenestra (when present)
240	**Mandible, dorsal border at dentary-surangular contact, in lateral view:** *Clark (1994, ch. 74); Sereno et al. (2003, ch. 41); Andrade et al. (2011, ch. 324); Ristevski et al. (2018, ds 1, ch. 324); Smith et al. (in review, ds 2, ch. 324); Ősi et al. (2018, ds 1, ch. 236).* *State (2) is putative apomorphy of Notosuchidae + Sphagesauridae + Comahuesuchidae.* 0. mostly straight 1. gently arched dorsally 2. strongly arched dorsally

Mandible (Ch. 241 – 272; 6.957% of characters)

[Dermatocranium mandibular series (= ossa dentalia, ossa splenialia, ossa angularia, ossa supraangularia, ossa præarticularia, ossa coronoidea); and the mandibular contribution of the splanchnocranium (= ossa articularia and cartilagines meckeli)]

#	Description
241	**Anterior mandible (dentary), dorsal margin of the anterior portion compared to the dorsal margin of the posterior portion:** *Nesbitt (2011, ch. 154); Young et al. (2012, ch. 129); Young (2014, ch. 133); Young et al. (2016, ds 2, ch. 155); Ristevski et al. (2018, ds 2, ch. 211); Smith et al. (in review, ds 1, ch. 215); Ősi et al. (2018, ds 1, ch. 237).* 0. horizontal (in the same plane) 1. ventrally deflected 2. dorsally expanded
242	**Anterior mandible (dentary), in dorsal or ventral view:** *Young et al. (2011, ch. 181 mod.); Young et al. (2013a, ch. 111 mod.); Young et al. (2012, ch. 130 mod.); Young (2014, ch. 135 mod.); Young et al. (2016, ds 2, ch. 156 mod.); Ristevski et al. (2018, ds 2, ch. 212); Smith et al. (in review, ds 1, ch. 216); Ősi et al. (2018, ds 1, ch. 238).* *Note, Ristevski et al. (2018, ds 2) added two new character states. These where added to determine whether the 'spatulate' anterior dentary morphotypes would homologous.* *State (1) occurs in most pholidosaurids, and in some dyrosaurids and eusuchians.* *State (2) is a putative apomorphy of Teleosauridae.* *State (3) is a putative apomorphy of* Sarcosuchus *and* Chalawan. 0. outer margin converging towards tip or parallel 1. distinct spatulate shape, with the maximum transverse width at the D2 alveoli 2. distinct spatulate shape, with the maximum transverse width at the D3-D4 couplet 3. distinct spatulate shape, with the maximum transverse width at the D4 alevoli
243	**Anterior mandible (dentary), in dorsal or ventral view:** *Young et al. (2016, ds 2, ch. 157 + 158); Ristevski et al. (2018, ds 2, ch. 213); Smith et al. (in review, ds 1, ch. 217); Ősi et al. (2018, ds 1, ch. 239).* *State (1) occurs in basal dyrosaurids and tomistomine crocodyloids*. *State (2) occurs in* Hamadasuchus, *Peirosauridae and* Baurusuchus. *States (1) and (2) differ in that the 'trowel'-shape has a shorter, broader and deeper symphyseal region; the anteriorly tapering maximal anterior width is more pronounced, and the width at the posterior symphyseal region is greater than the maximal anterior width.* 0. non-'gladius', or 'trowel'-shaped

	1. 'gladius'-shaped - i.e. a long symphyseal region with the anterior maximal width near the D3–D5 region, with the dentaries tapering anteriorly. Immediately posterior to the maximal width, the dentaries begin to narrow until they reach a minimal width, and begin expanding again. At the end of the symphyseal region the breadth is now wider than the anterior maximal width 2. 'trowel'-shaped - i.e. a moderate to short symphyseal region with the anterior maximal width near the D3–D5 region, with the dentaries tapering strongly anteriorly. Immediately posterior to the maximal width the dentaries begin to narrow until they reach a minimal width, and begin expanding again. At the end of the symphyseal region the breadth is either narrower or subequal to the anterior maximal width
244	**Mandibular symphysis, length:** *Young (2006, ch. 20 mod.); Wilkinson et al. (2008, ch. 43 mod.); Young & Andrade (2009, ch. 43 mod.); Young et al. (2011, ch. 43 mod.); Young et al. (2013a, ch. 112 mod.); Young et al. (2012, ch. 132); Young (2014, ch. 136); Young et al. (2016, ds 2, ch. 159); Ristevski et al. (2018, ds 2, ch. 214); Smith et al. (in review, ds 1, ch. 218); Ősi et al. (2018, ds 1, ch. 240).* 0. symphysis less than a third of mandible length (lower than 0.3) 1. symphysis less than half and more than a third of mandible length (between 0.3 and 0.45) 2. symphysis under half of mandible length (between 0.45 and 0.5) 3. symphysis greater than half of mandible length (more than 0.5)
245	**Mandibular symphysis, depth:** *Young (2006, ch. 21); Wilkinson et al. (2008, ch. 44); Young & Andrade (2009, ch. 44); Young et al. (2011, ch. 44); Young et al. (2013a, ch. 113); Young et al. (2012, ch. 133); Young (2014, ch. 137); Young et al. (2016, ds 2, ch. 160); Ristevski et al. (2018, ds 2, ch. 215); Smith et al. (in review, ds 1, ch. 219); Ősi et al. (2018, ds 1, ch. 241).* 0. deep (9% or more of mandible length) 1. moderate (6.5–8% of mandible length) 2. narrow (4.5–6% of mandible length) 3. very narrow (4% or less of mandible length)
246	**External mandibular fenestra, presence:** *Clark (1994, ch. 75 mod.d); Ortega et al. (2000, ch. 80 rev.); Young (2006, ch. 22 part); Wilkinson et al. (2008, ch. 45 part); Young & Andrade (2009, ch. 45 part); Andrade et al. (2011, ch. 312); Young et al. (2011, ch. 45 part); Young et al. (2013a, ch. 114 part); Young et al. (2012, ch. 134 part); Young (2014, ch. 138 part); Young et al. (2016, ds 2, ch. 161 part); Ristevski et al. (2018, ds 1, ch. 312); Smith et al. (in review, ds 2, ch. 312); Ősi et al. (2018, ds 1, ch. 242).* *State (0) occurs in Gobiosuchidae, Hylaeochampsidae, Bernissartiidae, Paralligatoridae and Metriorhynchidae. Also in derived goniopholidids (e.g.* Anteophthalmosuchus *and* Goniopholis *sensu stricto – Andrade et al., 2011), derived pholidosaurids (*Oceanosuchus *and* Terminonaris browni*), and within Dyrosauridae (*Sabinosuchus*).* 0. absent 1. present as a diminutive passage 2. present as an evident fenestra
247	**External mandibular fenestra, shape: (*)** *Andrade et al. (2011, ch. 315); Ristevski et al. (2018, ds 1, ch. 315); Smith et al. (in review, ds 2, ch. 315); Ősi et al. (2018, ds 1, ch. 243).* *This character is not applicable for taxa that lack external mandibular fenestrae.* 0. subcircular to poorly elliptic 1. highly elliptic, anteroposterior axis much longer than dorso-ventral axis, three time or more, but both ends rounded 2. slit-like, proportionally very long and both ends acute 3. broad teardrop-like 4. narrow teardrop-like 5. triangle
248	**External mandibular fenestra, morphology of anterior margin: (*)** *Andrade et al. (2011, ch. 316); Ristevski et al. (2018, ds 1, ch. 316); Smith et al. (in review, ds 2, ch. 316); Ősi et al. (2018, ds 1, ch. 244).*

	State (1) is present in peirosaurids, Araripesuchus *and closely related taxa.* *Note that* Baurusuchus *was reconstructed as (1), but is actually (0).* *This character is not applicable for taxa that lack external mandibular fenestrae.* 0. curved, with a broad arched margin anteriorly 1. anterodorsal and anteroventral margins poorly arched, meeting at an acute angle anteriorly, anterior end is wedge-like
249	**Surangular foramen, presence:** *Clark et al. (2004 mod.); Nesbitt (2007 mod.); Nesbitt (2011, ch. 163); Ősi et al. (2018, ds 1, ch. 245).* *State (1) is a putative apomorphy of* Junggarsuchus. *The foramen is located posterior to the external mandibular fenestra, and is surrounded by the surangular.* 0. present and small 1. present and large 2. absent
250	**Dentary, ventral margin strongly curved:** *Young et al. (2016, ds 2, ch. 162 + 163); Ristevski et al. (2018, ds 2, ch. 217); Smith et al. (in review, ds 1, ch. 221); Ősi et al. (2018, ds 1, ch. 246).* *State (1) occurs in* Junggarsuchus, Dakosaurus, Baurusuchus, *and in 'trematochampsids' and peirosaurids.* *State (2) occurs in* Pachycheilosuchus + Pietraroiasuchus*.* 0. no 1. yes, ventral margin is distinctly curved (convex). It rises sharply dorsally towards the anterior tip (this curvature occurs along the anterior ventral margin of the dentary) 2. yes, ventral margin is curved (concave). It rises dorsally towards the anterior tip (this curvature occurs along the anterior ventral margin of the dentary, from a dorsoventrally deepened region of the dentary, immediately anterior to the dentary-splenial suture)
251	**Dentary foramina, lateral and dorsal surface of the anterior (symphyseal) region of the dentary:** *Young et al. (2016, ds 2, ch. 164); Ristevski et al. (2018, ds 2, ch. 218); Smith et al. (in review, ds 1, ch. 222); Ősi et al. (2018, ds 1, ch. 247).* *State (1) is a putative apomorphy of* Dakosaurus*.* 0. foramina either small or variable in size. Number is variable. 1. has numerous small to medium-sized foramina
252	**Surangulodentary groove, morphology:** *Young (2006, ch. 23 mod.); Wilkinson et al. (2008, ch. 46 part); Young & Andrade (2009, ch. 46 part); Young et al. (2011, ch. 46 part); Young et al. (2013a, ch. 115 part); Young et al. (2012, ch. 135); Young (2014, ch.139); Young et al. (2016, ds 2, ch. 166); Ristevski et al. (2018, ds 2, ch. 220); Smith et al. (in review, ds 1, ch. 224); Ősi et al. (2018, ds 1, ch. 248).* *Note taphonomic or preservational damage can obscure state (1).* *State (2) is a putative apomorphy of the clade Geosaurini. Previously it was considered an apomorphy of* Dakosaurus*; however, the type specimens for the genera* Dakosaurus, Plesiosuchus *and* Geosaurus *share this morphology. The deep groove is also observed in the holotype of* Torvoneustes coryphaeus*, and large specimens of* Tyrannoneustes lythrodectikos*.* 0. absent 1. present as a subtle, shallow groove 2. deeply excavated
253	**Surangulodentary groove, relative length on both elements: (*)** *Young et al. (2013a, ch. 115 part); Young et al. (2012, ch. 136); Young (2014, ch. 140); Young et al. (2016, ds 2, ch. 167); Ristevski et al. (2018, ds 2, ch. 221); Smith et al. (in review, ds 1, ch. 225); Ősi et al. (2018, ds 1, ch. 249).* *This character is not applicable for taxa that lack the surangulodentary groove.* 0. groove is longer on the dentary than on the surangular 1. groove is as long on the dentary as on the surangular
254	**Surangulodentary groove, large foramen present at the dentary terminus: (*)** *Wilkinson et al. (2008, ch. 46 part); Young & Andrade (2009, ch. 46 part); Young et al. (2011, ch. 190); Young et al. (2013a, ch. 116); Young et al. (2012, ch. 137);*

	Young (2014, ch. 141); Young et al. (2016, ds 2, ch. 168); Ristevski et al. (2018, ds 2, ch. 222); Smith et al. (in review, ds 1, ch. 226); Ősi et al. (2018, ds 1, ch. 250). *This character is not applicable for taxa that lack the surangulodentary groove.* *State (1) is a putative apomorphy of* Dakosaurus. 0. absent 1. present
255	**Mandibular grooves, morphology along the dentary in lateral view: (*)** *Smith et al. (in review, ds 1, ch. 227); Ősi et al. (2018, ds 1, ch. 251).* *This character is not applicable for taxa that lack the surangulodentary groove.* *State (1) occurs in basal metriorhynchoids.* 0. the surangulodentary and angulodentary grooves are either poorly developed, not elongate, converge towards one another (i.e. they are not parallel, and close to one another ventral to the dentary rami tooth row 1. the surangulodentary and angulodentary grooves are parallel and positioned close to one another ventral to the dentary rami tooth row
256	**Splenial, involvement in mandibular symphysis:** *Young (2006, ch. 25 mod.); Wilkinson et al. (2008, ch. 49 mod.); Young & Andrade (2009, ch. 49 mod.); Young et al. (2011, ch. 49 mod.); Young et al. (2013a, ch. 117 mod.); Young et al. (2012, ch. 138 mod.); Young (2014, ch. 142); Young et al. (2016, ds 2, ch. 169 mod.); Ristevski et al. (2018, ds 2, ch. 223); Smith et al. (in review, ds 1, ch. 228); Ősi et al. (2018, ds 1, ch. 252).* 0. slight (less than 10% of symphysis length) 1. extensive (greater than, or equal to, 15% of symphysis length) 2. not involved
257	**Angular, in lateral view, extension of the anterior lateral ramus:** *Young (2006, ch. 24 part); Wilkinson et al. (2008, ch. 47 part); Young & Andrade (2009, ch. 47 part); Young et al. (2011, ch. 47 part); Young et al. (2013a, ch. 118 part); Young et al. (2012, ch. 139); Young (2014, ch. 143); Young et al. (2016, ds 2, ch. 170); Ristevski et al. (2018, ds 2, ch. 224); Smith et al. (in review, ds 1, ch. 229); Ősi et al. (2018, ds 1, ch. 253).* 0. short, does not extend beyond the orbits 1. long, does extend anteriorly beyond the orbits
258	**Angular, in lateral view, posterodorsal extension:** *Jouve et al. (2008, ch. 39 mod.); Hastings et al. (2010, ch. 79 mod.); Ristevski et al. (2018, ds 2, ch. 225); Smith et al. (in review, ds 1, ch. 230); Ősi et al. (2018, ds 1, ch. 254).* 0. reaches the retroarticular process 1. does not reach the retroarticular process
259	**Surangular, in lateral view, extension of the anterior lateral ramus:** *Young (2006, ch. 24 part); Wilkinson et al. (2008, ch. 47 part); Young & Andrade (2009, ch. 47 part); Andrade et al. (2011, ch. 346 mod.); Young et al. (2011, ch. 47 part); Young et al. (2013a, ch. 118 part); Young et al. (2012, ch. 140); Young (2014, ch. 144); Young et al. (2016, ds 2, ch. 171); Ristevski et al. (2018, ds 2, ch. 226); Smith et al. (in review, ds 1, ch. 231); Ősi et al. (2018, ds 1, ch. 255).* 0. short, does not extend anteriorly beyond the orbit 1. long, extends anteriorly beyond the orbit
260	**Surangular, along the dorsal margin of the mandible:** *Wilkinson et al. (2008, ch. 48); Young & Andrade (2009, ch. 48); Young et al. (2011, ch. 48); Young et al. (2013a, ch. 119); Young et al. (2012, ch. 141); Young (2014, ch. 145); Young et al. (2016, ds 2, ch. 172); Ristevski et al. (2018, ds 2, ch. 227); Smith et al. (in review, ds 1, ch. 232); Ősi et al. (2018, ds 1, ch. 256).* *This character does not always covary with the previous character, as in non-Rhacheosaurini metriorhynchines the dentary extensively overlaps the surangular (particularly in lateral view), obscuring its anterior development. The full extent of the surangular anterior development can only be determined by examining the dorsal margin in those taxa (e.g.,* Metriorhynchus superciliosus*).* 0. does not extend anteriorly beyond the orbit 1. does extend anteriorly beyond the orbit
261	**Surangular, presence of a distinct coronoid process:** *Young & Andrade (2009, ch. 155); Young et al. (2011, ch. 155); Young et al. (2013a, ch. 120); Young et al. (2012, ch. 142); Young (2014, ch. 146); Young et al.*

	(2016, ds 2, ch. 173); Ristevski et al. (2018, ds 2, ch. 228); Smith et al. (in review, ds 1, ch. 233); Ősi et al. (2018, ds 1, ch. 257). *In Crocodyliformes, state (1) occurs in Thalattosuchia and* Iharkutosuchus*.* *In Thalattosuchia it appears as though all taxa have a coronoid process. In teleosauroids the coronoid process is medially orientated and is not visible in lateral view, unlike in* Pelagosaurus + *Metriorhynchidae.* 0. absent 1. present
262	**Surangular, presence of extension to the retroarticular process:** *Norell (1988, ch. 42 mod.); Brochu (1999, ch. 51 rev.); Young & Andrade (2009, ch. 103); Andrade et al. (2011, ch. 350); Young et al. (2011, ch. 103); Young et al. (2013a, ch. 121); Young et al. (2012, ch. 143 mod.); Young (2014, ch. 147); Young et al. (2016, ds 2, ch. 174 mod.); Ristevski et al. (2018, ds 2, ch. 229); Smith et al. (in review, ds 1, ch. 234); Ősi et al. (2018, ds 1, ch. 258).* 0. absent, pinched off anterior to tip of retroarticular process, or surangular excluded from process 1. present, extends to posterior end of retroarticular process
263	**Prearticulars, presence:** *Clark (1994, ch. 72 rev.); Sereno et al. (2003, ch. 39); Young & Andrade (2009, ch. 89); Andrade et al. (2011, ch. 354); Young et al. (2011, ch. 89); Young et al. (2013a, ch. 122); Young et al. (2012, ch. 144); Young (2014, ch. 148); Young et al. (2016, ds 2, ch. 175); Ristevski et al. (2018, ds 2, ch. 230); Smith et al. (in review, ds 1, ch. 235); Ősi et al. (2018, ds 1, ch. 259).* *Note, here we follow Andrade et al. (2011) in scoring* Pholidosaurus schaumburgensis *and* Sarcosuchus imperator *as lacking prearticulars (as MTY also could not find these elements in first-hand observations). As such they are scored as (?).* *It is not possible to verify the potential prearticular in* Oceanosuchus *(Hua et al., 2007, Fig. 4U) as too much of the angular is not preserved. Thus, this OTU is scored as (?).* *State (1) occurs in Metasuchia.* 0. present 1. absent
264	**Coronoids:** *Jouve et al. (2005b, ch. 6 mod.); Jouve et al. (2008, ch. 6 mod.); Young & Andrade (2009, ch. 157 part); Hastings et al. (2010, ch. 77 mod.); Young et al. (2011, ch. 157 part); Young et al. (2013a, ch. 124 part); Young et al. (2012, ch. 146 part); Young (2014, ch. 150 part); Young et al. (2016, ds 2, ch. 177 part); Ristevski et al. (2018, ds 2, ch. 231); Smith et al. (in review, ds 1, ch. 236).* *This character is an amalgam of those in Hastings et al. (2010, ch. 77) and Young et al. (2016, ch. 177); Ősi et al. (2018, ds 1, ch. 260).* *State (1) occurs in derived Rhacheosaurini metriorhynchids.* *Dyrosaurids have state (2). However, to evaluate the presence of the coronoids requires well preserved specimens.* 0. present, but not exposed on the external (= lateral) surface of the mandible 1. present, and exposed on the external surface of the mandible 2. absent
265	**Coronoid, anterior development along the dorsal margin:** *Wilkinson et al. (2008, ch. 51 mod.); Young & Andrade (2009, ch. 51 mod.); Young et al. (2011, ch. 51 mod.); Young et al. (2013a, ch. 123 mod.); Young et al. (2012, ch. 145 mod.); Young (2014, ch. 149); Young et al. (2016, ds 2, ch. 176 mod.); Ristevski et al. (2018, ds 2, ch. 232); Smith et al. (in review, ds 1, ch. 237); Ősi et al. (2018, ds 1, ch. 261).* 0. does not project as far as the dentary tooth row, or coronoid absent 1. projects further anteriorly than the posterior-most alveoli
266	**Articular, glenoid fossa orientation:** *Young & Andrade (2009, ch. 154); Young et al. (2011, ch. 154); Young et al. (2013a, ch. 125); Young et al. (2012, ch. 147); Young (2014, ch. 151); Young et al. (2016, ds 2, ch. 178); Ristevski et al. (2018, ds 2, ch. 233); Smith et al. (in review, ds 1, ch. 238); Ősi et al. (2018, ds 1, ch. 262).* 0. anterodorsally

	1. dorsally
267	**Retroarticular process, development:** *Clark (1994, ch. 71 part); Andrade et al. (2011, ch. 358); Ristevski et al. (2018, ds 2, ch. 234); Smith et al. (in review, ds 1, ch. 239); Ősi et al. (2018, ds 1, ch. 263).* *For practical purposes, a retroarticular process is here considered as (1) when its orientation can be established.* *State (1) occurs in Mesoeucrocodylia.* 0. absent or poorly developed 1. present and evidently projecting posterior to glenoid fossa
268	**Retroarticular process, length of the attachment surface for the adductor muscles relative to its width: (*) (ORDERED)** *Jouve et al. (2005, ch. 1 mod.); Jouve et al. (2008, ch. 1 mod.), Andrade et al. (2011, ch. 359); Hastings et al. (2010, ch. 75 mod.); Ristevski et al. (2018, ds 2, ch. 235); Smith et al. (in review, ds 1, ch. 240); Ősi et al. (2018, ds 1, ch. 264).* *State (2) is a putative apomorphy of Dyrosauridae. Note, that in dyrosaurids the retroarticular processes also have a strong posterodorsal curvature.* *This character is not applicable for taxa that lack retroarticular processes.* 0. short, subequal 1. moderately elongated, evidently longer than wide 2. extremely elongate, more than twice its width
269	**Retroarticular process, morphology of the surface for the attachment of adductor muscles: (*)** *Wilkinson et al. (2008, ch. 50 mod.); Young & Andrade (2009, ch. 50 mod.); Andrade et al. (2011, ch. 363); Young et al. (2011, ch. 50 mod.); Young et al. (2013a, ch. 126 mod.); Young et al. (2012, ch. 148 mod.); Young (2014, ch. 152 mod.); Young et al. (2016, ds 2, ch. 179 mod.); Ristevski et al. (2018, ds 2, ch. 236); Smith et al. (in review, ds 1, ch. 241); Ősi et al. (2018, ds 1, ch. 265).* *This character is not applicable for taxa that lack retroarticular processes.* 0. trianglular 1. ellipsoid, rectangular or spoon-shaped 2. shovel-shaped (or paddle-shaped)
270	**Retroarticular process, width: (*)** *Young & Andrade (2009, ch. 152); Young et al. (2011, ch. 152); Young et al. (2013a, ch. 127); Young et al. (2012, ch. 149); Young (2014, ch. 153); Young et al. (2016, ds 2, ch. 180); Ristevski et al. (2018, ds 2, ch. 237); Smith et al. (in review, ds 1, ch. 242); Ősi et al. (2018, ds 1, ch. 266).* *This character is not applicable for taxa that lack retroarticular processes.* 0. narrower than the glenoid fossa 1. wider than the glenoid fossa (projecting medially past the glenoid fossa)
271	**Retroarticular process, length: (*)** *Young & Andrade (2009, ch. 153); Young et al. (2011, ch. 153); Young et al. (2013a, ch. 128); Young et al. (2012, ch. 150); Young (2014, ch. 154); Young et al. (2016, ds 2, ch. 181); Ristevski et al. (2018, ds 2, ch. 238); Smith et al. (in review, ds 1, ch. 243); Ősi et al. (2018, ds 1, ch. 267).* *This character is not applicable for taxa that lack retroarticular processes.* 0. long (longer than wide, and longer than the glenoid fossa width) 1. short (wider than long, and shorter than the glenoid fossa width)
272	**Retroarticular process, position of the posteromedial wing: (*)** *Jouve et al. (2005b, ch. 2); Jouve et al. (2008, ch. 2); Hastings et al. (2010, ch. 76); Andrade et al. (2011, ch. 365); Ristevski et al. (2018, ds 2, ch. 239); Smith et al. (in review, ds 1, ch. 244); Ősi et al. (2018, ds 1, ch. 268).* *State (1) is a putative apomorphy of Dyrosauridae.* *This character is not applicable for taxa that lack retroarticular processes.* 0. posteromedial wing dorsally situated, or at mid height on the retroarticular process 1. posteromedial wing ventrally situated on the retroarticular process

Dentition and alveolar morphologies (Ch. 273 – 337; 14.130% of characters)

[Note abbreviations used in this section: P = premaxilla, M = maxilla, D = dentary. Thus, D1 would refer to the first dentary alveolus, while M4 would be the fourth maxillary alveolus, etc. Tooth count numbering starts from the anterior-most alveolus.]

#	Description
273	**Tooth row, premaxillary alveoli and posterior maxillary alveoli:** *Young & Andrade (2009, ch. 129); Young et al. (2011, ch. 129); Young et al. (2013a, ch. 3); Young et al. (2012, ch. 5); Young (2014, ch. 5); Young et al. (2016, ds 2, ch. 6), Ristevski et al. (2018, ds 2, ch. 13); Smith et al. (in review, ds 1, ch. 14); Ősi et al. (2018, ds 1, ch. 269).* *State (1) is a putative apomorphy of Metriorhynchidae.* *Note that the ventral offset scored by this character is formed by the dorsoventral expansion of the orbits, this results in the ventroposterior curvature of the posterior maxillae (and thus the concave maxillary tooth row).* 0. upper tooth row largely in the same plane (excludes maxillary deflections) 1. posterior maxillary alveoli ventral to all other alveoli (caused by the ventroposterior curvature of the posterior maxillae)
274	**Premaxilla, alveolar count:** *Young (2006, ch. 26 mod.); Wilkinson et al. (2008, ch. 52 mod.); Young & Andrade (2009, ch. 52 mod.); Nesbitt (2011, ch. 6 mod.); Young et al. (2011, ch. 52 mod.); Young et al. (2013a, ch. 129 mod.); Young et al. (2012, ch. 151 mod.); Young (2014, ch. 155 mod.); Young et al. (2016, ds 2, ch. 182 mod.); Ristevski et al. (2018, ds 2, ch. 240 mod.); Smith et al. (in review, ds 1, ch. 245 mod.); Ősi et al. (2018, ds 1, ch. 270).* *State (0) occurs in* Anatosuchus. 0. six or more alveoli 1. five alveoli 2. four alveoli 3. three or fewer alveoli
275	**Maxilla, alveolar count:** *Young (2006, ch. 27 mod.); Wilkinson et al. (2008, ch. 53 mod.); Young & Andrade (2009, ch. 53 mod.); Young et al. (2011, ch. 53 mod.); Young et al. (2013a, ch. 130 mod.); Young et al. (2012, ch. 152 mod.); Young (2014, ch. 156); Young et al. (2016, ds 2, ch. 183); Ristevski et al. (2018, ds 2, ch. 241); Smith et al. (in review, ds 1, ch. 246); Ősi et al. (2018, ds 1, ch. 271).* 0. 11 or fewer alveoli 1. 12–16 alveoli 2. 17–20 alveoli 3. 21–28 alveoli 4. 29 or more alveoli
276	**Maxilla, end of the alveolar row:** *Ristevski et al. (2018, ds 2, ch. 242); Smith et al. (in review, ds 1, ch. 247); Ősi et al. (2018, ds 1, ch. 272).* *State (0) occurs in Dyrosauridae.* *State (2) occurs in the metriorhynchid subclade* Tyrannoneustes lythrodectikos, Purranisaurus, Torvoneustes, 'Metriorhynchus' hastifer + *Mr. Passmore's specimen. . It also occurs in* C. elegans *and* C. suevicus*. It also occurs in Baurusuchidae,* Stolokrosuchus *and* Kaprosuchus + Mahajangasuchus*.* 0. maxillary tooth row terminates posterior to the posterior margin of the orbit, but does not extend beyond the anteroposterior mid-length of the supratemporal fenestrae 1. maxillary tooth row terminates level to, or posterior to, the anterior margin of the orbit 2. maxillary tooth row terminates prior to the anterior margin of the orbit
277	**Premaxilla, P1 and P2 are lateral to one another: (*)** *State (1) occurs in the teleosauroids* Aeolodon priscus*,* Bathysuchus megarhinus*, and* Mycterosuchus nasutus. *State (1) also occurs in Pholidosauridae.* *State (2) occurs in* Elosuchus. 0. no, P2 posterolateral

	1. yes, both alveoli are in the same transverse plane 2. the P2 alveolus is anterolateral to the P1 alveolus
278	**Premaxilla, P3 is posterolaterally positioned to P2: (*)** *State (1) occurs in* Aeolodon priscus*,* Bathysuchus megarhinus*, and* Mycterosuchus nasutus. *Note that this morphology does not occur in Pholidosauridae, which have a semi-circular shaped premaxilla in dorsal view. Thus, how the P1-P2 alveoli are in the same transverse plane, and its structural implications for premaxillary shape differ between teleosauroids and pholidosaurids.* 0. premaxilla lateral margins are clearly curved, with the P3 alveoli being either: in-line, posteromedial or posterolateral to the P2 alveoli 1. premaxilla lateral margins subrectangular, with the P3 alveoli being clearly lateral to the P2 alveoli (i.e. not part of a curving tooth-row)
279	**Third premaxillary alveoli, relative size when more than three premaxillary alveoli are present: (*)** *Hastings et al. (2010, ch. 16 mod.); Ristevski et al. (2018, ds 2, ch. 243); Smith et al. (in review, ds 1, ch. 248); Ősi et al. (2018, ds 1, ch. 273).* *This character is not applicable for taxa that have fewer than four premaxillary alveoli.* 0. not enlarged relative to both the second and fourth premaxillary alveoli 1. third alveoli are enlarged relative to both adjacent alveoli
280	**Premaxilla, tooth row: (ORDERED)** *Sereno et al. (2001, ch. 69 mod.); Turner & Buckley (2008, ch. 240 mod.); Andrade et al. (2011, ch. 390 mod.); Young et al. (2016, ds 2, ch. 12 mod.), Ristevski et al. (2018, ds 2, ch. 25); Smith et al. (in review, ds 1, ch. 26); Ősi et al. (2018, ds 1, ch. 274).* *State (2) occurs in the pholidosaurids* Chalawan, Sarcosuchus, Pholidosaurus schaumburgensis *(based on the German natural mould specimens) and* Meridiosaurus. *The morphology in* Elosuchus *and the French* Pholidosaurus *approaches this condition, however the P5 is directed posteriorly and the premaxilla has definitive lateral margins rather than a curved anterolateral curve (however, this could be due to the enlargement of the P3 alveoli). Here, we have created a new character state (1) to accommodate this morphology.* *State (3) is a modification seen in* Terminonaris *and* Oceanosuchus*.* 0. alveoli along the anterior and lateral margins 1. in a slight semi-circle, (similar to state 2), but the P5 alveolar are directly posteriorly, and the premaxilla still has definitive lateral margins rather than a true anterolateral curve 2. in a slight semi-circle, resulting in the premaxillary alveoli being restricted to the anterior and anterolateral margins 3. the premaxillary tooth row is restricted to an even tighter curve, resulting in the P5 alveoli being lateral to the P4 alveoli and being somewhat laterally oriented (compared to the other four alveoli). The tighter curve means the normally very transversely wide premaxilla of pholidosaurids is now much less wide (with the maximal width at the P5)
281	**Number of teeth partially supported by both the premaxilla and maxilla:** *Young & Andrade (2009, ch. 162); Young et al. (2011, ch. 162); Young et al. (2013a, ch. 131); Young et al. (2012, ch. 153); Young (2014, ch. 157); Young et al. (2016, ds 2, ch. 184); Ristevski et al. (2018, ds 2, ch. 244); Smith et al. (in review, ds 1, ch. 249); Ősi et al. (2018, ds 1, ch. 275).* *State (1) occurs in* Mariliasuchus *and* Notosuchus. 0. none 1. one
282	**Presence of a premaxillary lamina extending posteriorly along the palatal surface that overlaps the anterior margin of the first maxillary alveoli:** *Ristevski et al. (2018, ds 2, ch. 245); Smith et al. (in review, ds 1, ch. 250); Ősi et al. (2018, ds 1, ch. 276).* *State (1) occurs in* Tyrannoneustes lythrodectikos, Torvoneustes, 'Metriorhynchus' hastifer *and Mr. Passmore's specimen.* 0. absent 1. present

283	**Anterior margin of maxillary alveolus one:** *Ristevski et al. (2018, ds 2, ch. 246); Smith et al. (in review, ds 1, ch. 251); Ősi et al. (2018, ds 1, ch. 277).* *State (1) occurs in* Metriorhynchus superciliosus *and* M. geoffroyii. 0. lacks an interdigitating suture with the premaxilla 1. has an interdigitating suture with the premaxilla, restricted to the anterior margin of the first maxillary alveolus
284	**Dentary, alveolar count:** *Young (2006, ch. 28 mod.); Wilkinson et al. (2008, ch. 54 mod.); Young & Andrade (2009, ch. 54 mod.); Young et al. (2011, ch. 54 mod.); Young et al. (2013a, ch. 132 mod.); Young et al. (2012, ch. 154); Young (2014, ch. 158); Young et al. (2016, ds 2, ch. 185); Ristevski et al. (2018, ds 2, ch. 247); Smith et al. (in review, ds 1, ch. 252); Ősi et al. (2018, ds 1, ch. 278).* *This character does not covary with the maxillary alveolar count character, as some taxa (e.g.* 'Metriorhynchus' casamiquelai*) have more teeth in the dentary than in the maxilla.* 0. 30 or more alveoli per rami 1. 20–29 alveoli 2. 19–15 alveoli 3. 14 or fewer alveoli
285	**Maxillary anterior alveoli shape:** *Young et al. (2016, ds 2, ch. 186); Ristevski et al. (2018, ds 2, ch. 248); Smith et al. (in review, ds 1, ch. 253); Ősi et al. (2018, ds 1, ch. 279).* *In Thalattosuchia, state (1) is a putative apomorphy of the clade* 'Metriorhynchus' hastifer *and Mr. Passmore's specimen.* *Note that shearing or crushing of the snout can make this character hard to discern.* 0. sub-circular 1. sub-oval, being wider transversely than anteroposteriorly
286	**Maxillary interalveolar spaces, relative size:** *Young (2014, ch. 159); Young et al. (2016, ds 2, ch. 187); Ristevski et al. (2018, ds 2, ch. 249); Smith et al. (in review, ds 1, ch. 254); Ősi et al. (2018, ds 1, ch. 280).* *State (1) is a putative apomorphy of* Dakosaurus + Plesiosuchus *sub-clade and* Gracilineustes leedsi. *This character correlates with the dentary interalveolar space character for the metriorhynchids* Gracilineustes leedsi and *the* Dakosaurus + Plesiosuchus *sub-clade*; *however, the maxillary interalveolar spacing does not correlate with the dentary character for the teleosaurid* Machimosaurus hugii. *State (1) does not occur in* Torvoneustes carpenteri, 'Metriorhynchus' hastifer *and Mr. Passmore's specimen as some interalveolar spaces are large, over half the length of the adjacent alveoli and they do not alway share the same alveolar lamina. They appear to evolve an analogous, but slightly different morphology, which has not yet been scored.* *State (1) also occurs in* Iharkutosuchus makadii. 0. Interalveolar spaces are variable in size, some are similar in length to the adjacent alveoli, while others are approximately half the length of the immediately adjacent alveoli (especially towards the end of the maxillary tooth row) 1. Interalveolar spaces are/almost completely uniformly narrow, being approximately one quarter the length of the adjacent alveoli (or even smaller). The adjacent alveoli share the same alveolar lamina.
287	**Dentary tooth-row, distinctly sigmoidal:** *Young et al. (2016, ds 2, ch. 165); Ristevski et al. (2018, ds 2, ch. 219); Smith et al. (in review, ds 1, ch. 223); Ősi et al. (2018, ds 1, ch. 281).* *State (1) occurs in Hylaeochampsidae.* 0. no 1. yes, with the anterior alveoli orientated slightly anterolaterally and the posterior alveoli orientated posteromedially, between these two orientations the mid-region alveoli become dorsally orientated
288	**Dentary alveoli one, orientation:** *Young et al. (2016, ds 2, ch. 188); Ristevski et al. (2018, ds 2, ch. 250); Smith et al. (in review, ds 1, ch. 255); Ősi et al. (2018, ds 1, ch. 282).*

	State (1) occurs in Tethysuchia (e.g. dyrosaurids, Sarcosuchus, Chalawan) *and* Hamadasuchus. *State (2) occurs in the* Pachycheilosuchus + Pietraroiasuchus *clade,* Iharkutosuchus makadii, Dakosaurus *and* Maledictosuchus riclaensis. *This morphology differs from the procumbency of the first dentary alveolus seen in* Cricosaurus aracuanensis*, as they are also partially laterally orientated.* 0. dorsally orientated 1. mainly dorsally orientated, but with a slight anterior orientation 2. strongly anteriorly orientated (procumbent), resulting in the first dentary tooth being directed anteriorly from the mouth, along anteroposterior axis of the skull
289	**Dentary interalveolar spaces, relative size:** *Young (2014, ch. 160); Young et al. (2012, ch. 131 mod.); Young et al. (2016, ds 2, ch. 189); Ristevski et al. (2018, ds 2, ch. 251); Smith et al. (in review, ds 1, ch. 256); Ősi et al. (2018, ds 1, ch. 283).* *State (1) occurs in the thalattosuchians* Dakosaurus + Plesiosuchus *sub-clade,* Gracilineustes leedsi *and* Machimosaurus hugii. *It also occurs in* Iharkutosuchus makadii*.* *This character correlates with the maxillary interalveolar space character for the metriorhynchids* Gracilineustes leedsi *and the* Dakosaurus + Plesiosuchus *sub-clade, and for the hylaeochampsid* Iharkutosuchus makadii*, but does not for the teleosaurid* Machimosaurus hugii. 0. interalveolar spaces are variable in size, some are similar in length to the adjacent alveoli, while others are approximately half the length of the immediately adjacent alveoli 1. interalveolar spaces are/almost completely uniformly narrow, being approximately one quarter the length of the immediately adjacent alveoli (or even smaller)
290	**Dentary alveoli, diastema between the first and second alveoli:** *Young et al. (2016, ds 2, ch. 190); Ristevski et al. (2018, ds 2, ch. 252); Smith et al. (in review, ds 1, ch. 257) Ősi et al. (2018, ds 1, ch. 284).* *State (1) is a putative apomorphy of* Dakosaurus maximus*.* 0. absent 1. present
291	**Dentary alveoli 1–2, confluence:** *Andrade et al. (2011, ch. 402); Young et al. (2016, ds 2, ch. 191); Ristevski et al. (2018, ds 2, ch. 253); Smith et al. (in review, ds 1, ch. 258); Ősi et al. (2018, ds 1, ch. 285).* *State (1) is a putative apomorphy of Goniopholis.* 0. well-separated, usually as much distant from each other as from other dentary teeth 1. alveoli 1–2 confluent, separated by a thin alveolar wall, and clearly apart from neighbouring alveoli
292	**D2 alveoli, size relative to D1 alveoli:** *Hastings et al. (2010, ch. 64 mod.); Young et al. (2016, ds 2, ch. 192); Ristevski et al. (2018, ds 2, ch. 254); Smith et al. (in review, ds 1, ch. 259); Ősi et al. (2018, ds 1, ch. 286).* 0. similar in size 1. reduced in size relative to both adjacent alveoli
293	**D3 alveoli, position:** *Hastings et al. (2010, ch. 66 mod.); Ristevski et al. (2018, ds 2, ch. 255); Smith et al. (in review, ds 1, ch. 260); Ősi et al. (2018, ds 1, ch. 287).* 0. interalveolar space between D2 and D3 is approximately equal to that between D3 and D4 1. closer to the D4 alveoli
294	**Interalveolar space between the D2 and D3 alveoli relative to that of the D1 and D2 alveoli:** *Hastings et al. (2010, ch. 65 mod.); Young et al. (2016, ds 2, ch. 193); Ristevski et al. (2018, ds 2, ch. 256); Smith et al. (in review, ds 1, ch. 261); Ősi et al. (2018, ds 1, ch. 288).* 0. approximately equal in proportion 1. the D2–D3 interalveolar space is longer than the interalveolar space between the D1 and D2

295	**D4 alveolar wall:** *Hastings et al. (2010, ch. 68 mod.); Young et al. (2016, ds 2, ch. 194); Ristevski et al. (2018, ds 2, ch. 257); Smith et al. (in review, ds 1, ch. 262); Ősi et al. (2018, ds 1, ch. 289).* 0. level with the adjacent alveoli 1. raised relative to the adjacent alveoli
296	**Dentary alveoli, diastema present between the fourth and fifth alveoli:** *Young (2014, ch. 161); Young et al. (2016, ds 2, ch. 195); Ristevski et al. (2018, ds 2, ch. 258); Smith et al. (in review, ds 1, ch. 263); Ősi et al. (2018, ds 1, ch. 290).* *State (1) is a putative apomorphy of Thalattosuchia and* Sarcosuchus. *Within Thalattosuchia: state (0) is a putative apomorphy of the* Dakosaurus + Plesiosuchus *sub-clade.* *Note that while the very small dentary interalveolar spaces are putative apomorphies of* Dakosaurus, Plesiosuchus *and* Gracilineustes leedsi*, the D4–D5 diastema is still present in* Gracilineustes leedsi. 0. absent 1. present
297	**D7 alveoli, size:** *Jouve (2004, ch. 153 mod.); Jouve (2005, ch. 3 mod.); Jouve et al. (2005b, ch. 8 mod.); Jouve et al. (2006, ch. 164 mod.); Jouve et al. (2008, ch. 8 mod.); Hastings et al. (2010, ch. 73 mod.); Young et al. (2016, ds 2, ch. 196 mod.); Ristevski et al. (2018, ds 2, ch. 259); Smith et al. (in review, ds 1, ch. 264); Ősi et al. (2018, ds 1, ch. 291).* *State (1) occurs in Dyrosauridae.* 0. comparable in size to the adjacent alveoli 1. reduced in size compared to the adjacent alveoli
298	**D7 alveoli, position:** *Jouve (2004, ch. 153 mod.); Jouve (2005a, ch. 3 mod.); Jouve et al. (2005b, ch. 8 mod.); Jouve et al. (2006, ch. 164 mod.); Jouve et al. (2008, ch. 8 mod.); Hastings et al. (2010, ch. 73 mod.); Young et al. (2016, ds 2, ch. 197 mod.); Ristevski et al. (2018, ds 2, ch. 260); Smith et al. (in review, ds 1, ch. 265); Ősi et al. (2018, ds 1, ch. 292).* *State (1) occurs in Dyrosauridae.* 0. comparable in size to the adjacent alveoli 1. close in position to the eighth alveoli
299	**Dentary alveoli, number of alveoli adjacent to the mandibular symphysis:** *Young (2014, ch. 162); Young et al. (2016, ds 2, ch. 198); Ristevski et al. (2018, ds 2, ch. 261); Smith et al. (in review, ds 1, ch. 266); Ősi et al. (2018, ds 1, ch. 293).* *Within Thalattosuchia: state (3) is a putative apomorphy of* Dakosaurus. 0. 15 or more 1. 10 to 14 2. 7 to 9 3. 4 to 6 4. fewer than 4
300	**Premaxilla-anterior maxillary tooth crown apicobasal length to basal width ratio:** *Young et al. (2012, ch. 155); Young (2014, ch. 163); Young et al. (2016, ds 2, ch. 199); Ristevski et al. (2018, ds 2, ch. 262); Smith et al. (in review, ds 1, ch. 267); Ősi et al. (2018, ds 1, ch. 294).* 0. 3 or greater 1. 2.5 or less
301	**Anterior maxilla, crown size:** *Wilkinson et al. (2008, ch. 56); Young & Andrade (2009, ch. 56); Young et al. (2011, ch. 56); Young et al. (2013a, ch. 133); Young et al. (2012, ch. 156); Young (2014, ch. 164); Young et al. (2016, ds 2, ch. 200); Ristevski et al. (2018, ds 2, ch. 263); Smith et al. (in review, ds 1, ch. 268); Ősi et al. (2018, ds 1, ch. 295).* *It is currently unknown if this character correlates with the character quantifying mandibular symphysis depth across Crocodylomorpha. However, in Geosaurinae this is not the case, as shown by Young et al. (2013), the symphysis is deeper in* 'Metriorhynchus' brachyrhynchus *than* Tyrannoneustes lythrodectikos*, but the latter has tooth crowns with a greater apicobasal length. Moreover, the symphyseal depth*

	of Dakosaurus maximus *and* Plesiosuchus manselii *noticeably differ, but both taxa have tooth crowns similar in apicobasal length (Young et al., 2012).* *Anterior maxilla = tooth crowns of the anterior half of the maxillary tooth row.* 0. crowns not enlarged (typically less than 3cm in apicobasal length) 1. moderately enlarged (between 3 and 4 cm in apicobasal length) 2. enlarged (apicobasal length 5 cm or greater)
302	**Anterior maxilla, mediolateral compression/crown cross section:** *Young (2006, ch. 30); Wilkinson et al. (2008, ch. 57); Young & Andrade (2009, ch. 57); Young et al. (2011, ch. 57); Young et al. (2013a, ch. 134 mod.); Young et al. (2012, ch. 157); Young (2014, ch. 165); Young et al. (2016, ds 2, ch. 201); Ristevski et al. (2018, ds 2, ch. 264); Smith et al. (in review, ds 1, ch. 269); Ősi et al. (2018, ds 1, ch. 296).* 0. no mediolateral compression 1. weak mediolateral compression (crown midpoint labiolingual width 60–90% distal-medial width) 2. strong mediolateral compression (crown midpoint labiolingual width less than 60% distal-medial width)
303	**Anterior maxilla, constriction at base of crowns:** *Young (2006, ch. 32); Wilkinson et al. (2008, ch. 59); Young & Andrade (2009, ch. 59); Young et al. (2011, ch. 59); Young et al. (2013a, ch. 135); Young et al. (2012, ch. 159); Young (2014, ch. 167); Young et al. (2016, ch. 203); Ristevski et al. (2018, ds 2, ch. 266); Smith et al. (in review, ds 1, ch. 271); Ősi et al. (2018, ds 1, ch. 297).* 0. absent 1. present
304	**Maxillary teeth, orientation of the anterior to mid-snout crowns:** *Young & Andrade (2009, ch. 123); Young et al. (2011, ch. 123); Young et al. (2013a, ch. 136); Young et al. (2012, ch. 160); Young (2014, ch. 168); Young et al. (2016, ds 2, ch. 204); Ristevski et al. (2018, ds 2, ch. 267); Smith et al. (in review, ds 1, ch. 272); Ősi et al. (2018, ds 1, ch. 298).* 0. not procumbent 1. procumbent
305	**Posterior maxilla, presence of enamel bands:** *Gasparini et al. (2006, ch. 242); Andrade et al. (2011, ch. 418); Young et al. (2011, ch. 167); Young et al. (2013a, ch. 137); Young et al. (2012, ch. 161); Young (2014, ch. 169); Young et al. (2016, ds 2, ch. 205); Ristevski et al. (2018, ds 2, ch. 268); Smith et al. (in review, ds 1, ch. 273); Ősi et al. (2018, ds 1, ch. 299).* *'Enamel bands' follow the definition by Brusatte et al. (2007).* *Posterior maxilla = tooth crowns in the posterior half of the maxillary tooth row.* *State (1) occurs in* Dakosaurus *and* Geosaurus*.* 0. absent 1. present
306	**Anterior maxilla, tooth crown tip:** *Young et al. (2011, ch. 183); Young et al. (2013a, ch. 138); Young et al. (2012, ch. 162); Young (2014, ch. 170); Young et al. (2016, ds 2, ch. 206); Ristevski et al. (2018, ds 2, ch. 269); Smith et al. (in review, ds 1, ch. 274); Ősi et al. (2018, ds 1, ch. 300).* 0. sharp or worn apex 1. blunt and rounded at the tips
307	**Dentary tooth opposite to premaxilla-maxilla contact, isometry:** *based on Clark (1994, ch. 80); Wilkinson et al. (2008, ch. 60); Young & Andrade (2009, ch. 60); Andrade et al. (2011, ch. 408); Young et al. (2011, ch. 60); Young et al. (2013a, ch. 139); Young et al. (2012, ch. 163); Young (2014, ch. 171); Young et al. (2016, ds 2, ch. 207); Ristevski et al. (2018, ds 1, ch. 408); Smith et al. (in review, ds 2, ch. 408); Ősi et al. (2018, ds 1, ch. 301).* *Alveolar size may be used as a reasonable proxy for crown size, when teeth are not preserved.* 0. subequal to other neighbouring teeth 1. tooth is at least evidently enlarged, anisometric relative to other neighbouring teeth
308	**Dentary tooth opposite to premaxilla-maxilla contact, length:**

	Clark (1994, ch. 80); Sereno et al. (2003, ch. 54); Andrade & Bertini (2008a, ch. 142); Andrade et al. (2011, ch. 409); Ristevski et al. (2018, ds 1, ch. 409); Smith et al. (in review, ds 2, ch. 409); Ősi et al. (2018, ds 1, ch. 302). *Alveolar size may be used as a reasonable proxy for crown size, when teeth are not preserved.* 0. small to medium sized, but length is no more than twice the length of other neighbouring teeth 1. hypertrophied, at least twice longer than neighboring teeth
309	**Dentary tooth opposite to premaxillary-maxillary suture, occlusion:** *Norell (1988, ch. 29); Brochu (1999, ch. 77 mod.); Andrade et al. (2011, ch. 410); Ristevski et al. (2018, ds 1, ch. 410); Smith et al. (in review, ds 2, ch. 410); Ősi et al. (2018, ds 1, ch. 303).* *The series cannot be ordered, as a transition between states (0) - (2) is possible without intermediate steps.* 0. occludes either in notch at premaxilla and maxilla early in ontogeny, or lateral to premaxilla-maxilla suture, when the notch is absent or poorly defined 1. occludes in a pit between premaxilla and maxilla; no notch early in ontogeny 2. occludes medial to premaxilla-maxilla suture, but not in a pit or a notch
310	**Dentary tooth occluding against premaxillary-maxillary suture:** *based on Norell (1988, ch. 29) and Clark (1994, ch. 80) and Brochu (1999, ch. 77); Andrade et al. (2011, ch. 411); Ristevski et al. (2018, ds 1, ch. 411); Smith et al. (in review, ds 2, ch. 411); Ősi et al. (2018, ds 1, ch. 304).* *The tooth occluding to the premaxillomaxillary suture is usually seen as the fourth dentary tooth, but in Crocodylomorpha this may be another tooth due to the loss of anterior teeth or other morphological adaptation. The tooth is not necessarily enlarged, and may be isometric to neighbouring teeth.* *State (0) is putative apomorphy of* Mahajangasuchus, *Sphagesauridae, and Teleosauridae.* *State (2) is putative apomorphy of* Sarcosuchus*.* *Note that in teleosaurids, the D3 tooth contacts the premaxilla-maxilla suture, not the D4 tooth, due to the orientation of the D3-D4 couplet.* 0. third, or anterior 1. fourth 2. fifth, or posterior
311	**Dentition, relation between tooth rows on both sides of the skull:** *Novas et al. (2009); Andrade et al. (2011, ch. 367); Ristevski et al. (2018, ds 1, ch. 367); Smith et al. (in review, ds 2, ch. 367); Ősi et al. (2018, ds 1, ch. 305).* *State (1) is putative autapomorphy of* Yacarerani*, where maxillary tooth rows converge at mid-palate, the same occurring with the dentition in the mandible. As a consequence, anterior teeth (pairs 1-4) both in the upper and lower dentition constitute functionally distinct sets, one anterior and one posterior. Teeth at the posterior set (mid-dentition) are located close to the median line of the skull, with first tooth at least almost in contact with its complementary tooth.* 0. forming one continuous set of teeth, both in the cranium and mandible 1. forming two distinct sets, tooth rows at posterior set convergent rostrally and almost in touch each other, at mid-palate and mandible
312	**Posterior maxillary teeth, transverse section:** *Buckley et al. (2000, ch. 116 mod.); Ortega et al. (2000, ch. 104 mod.); Andrade & Bertini (2008, ch. 135); Andrade et al. (2011, ch. 368); Ristevski et al. (2018, ds 1, ch. 368); Smith et al. (in review, ds 2, ch. 368); Ősi et al. (2018, ds 1, ch. 306).* 0. evident lateral compression affecting both edges of the crown, making both edges evident regardless of the presence/absence of carinae/keel 1. transverse section circular to subcircular, without significant lateral compression 2. transverse section 'teardrop-like' (= triangular), with asymmetric lateral compression occurring on the distal margin only
313	**Mid to posterior mandibular teeth, transverse section:** *Buckley et al. (2000, ch. 116 mod.); Ortega et al. (2000, ch. 104 mod.); as in Andrade & Bertini (2008, ch. 146); Andrade et al. (2011, ch. 369); Ristevski et al. (2018, ds 1, ch. 369); Smith et al. (in review, ds 2, ch. 369); Ősi et al. (2018, ds 1, ch. 307).*

	0. evident lateral compression affecting the entire crown, making evident both mesial and distal edges, regardless of the presence/absence of carinae/keel 1. transverse section circular to subcircular, without significant lateral compression 2. transverse section 'teardrop-like' (= triangular), with asymmetric lateral compression occurring on the mesial margin only
314	**Dentition, presence of apicobasal facets on the labial sufrace:** *Young & Andrade (2009, ch. 130); Andrade et al. (2011, ch. 370); Young et al. (2011, ch. 130); Young et al. (2013a, ch. 140); Young et al. (2012, ch. 164); Young (2014, ch. 172); Young et al. (2016, ds 2, ch. 208); Ristevski et al. (2018, ds 2, ch. 271); Smith et al. (in review, ds 1, ch. 276); Ősi et al. (2018, ds 1, ch. 308).* *State (1) is a putative apomorphy of* Geosaurus giganteus, G. grandis + Ieldraan melkshamensis. 0. absent, either lacking facets, or facetted into 4–5 indistinct planes 1. present, most crowns have the labial surface distinctly facetted into three planes (one large medial one, and two smaller planes either side)
315	**Dentition, presence of laminar teeth:** *Andrade et al. (2011, ch. 371); Young et al. (2011, ch. 170); Young et al. (2013a, ch. 141); Young et al. (2012, ch. 165); Young (2014, ch. 173); Young et al. (2016, ds 2, ch. 209); Ristevski et al. (2018, ds 2, ch. 272); Smith et al. (in review, ds 1, ch. 277); Ősi et al. (2018, ds 1, ch. 309).* *State (1) is a putative apomorphy of Geosaurina (*Geosaurus + Ieldraan*).* *For practical purposes, 'laminar tooth' are here considered as teeth with cross-section highly elliptical at the base of crown, with mesial-distal axis approximately twice the labial-lingual axis, or greater.* 0. absent 1. present, laminar teeth dominate dentition
316	**Dentition, presence of spatulated teeth:** *Buckley et al. (2000, ch. 116 mod.); Andrade et al. (2011, ch. 372); Ristevski et al. (2018, ds 1, ch. 372); Smith et al. (in review, ds 2, ch. 372); Ősi et al. (2018, ds 1, ch. 310).* *The spatulated morphology refers to the morphology of the crown, not simply its compression, number of cusps or presence of cingula. Therefore, it is considered as a different character, and treated separately. However, all spatulated teeth are considered as laterally compressed.* *State (1) occurs in* Candidodon, Malawisuchus *and* Uruguaysuchus*.* 0. absent 1. present
317	**Dentition, presence of tribodont teeth in both the posterior maxillae and dentaries:** *Ristevski et al. (2018, ds 2, ch. 274); Smith et al. (in review, ds 1, ch. 279); Ősi et al. (2018, ds 1, ch. 311).* *State (1) occurs in Bernissartiidae and in some alligatoroids*. *For practical purposes, 'tribodont teeth' are here considered as teeth that are 'low crowned', bulbous, mesiodistally compressed, single cusped, and lack carinae.* 0. absent 1. present
318	**Mid to posterior dentition, presence of pebbled ornamentation on tooth crown surface:** *Andrade et al. (2011, ch. 374); Ristevski et al. (2018, ds 1, ch. 374); Smith et al. (in review, ds 2, ch. 374); Ősi et al. (2018, ds 1, ch. 312).* *State (1) is putative apomorphy of Sphagesauridae.* 0. absent 1. present, enamel ornamented with a peebled pattern
319	**Mid to posterior dentition, presence of accessory ridges on labial-lingual surfaces of crown:** *Andrade et al. (2011, ch. 376); Ristevski et al. (2018, ds 1, ch. 376); Smith et al. (in review, ds 2, ch. 376); Ősi et al. (2018, ds 1, ch. 313).* *The ridges present in* Notosuchus *and sphagesaurids do involve enamel and dentine, therefore should not be considered as superficial ornamentation.* *State (1) occurs in* Notosuchus *and in derived sphagesaurids (i.e. not* Adamantinasuchus *and* Yacareni*).*

	0. absent 1. present, apicobasal, evident and well-spaced, formed by enamel and dentine
320	**Mid to posterior dentition, number of cusps per tooth:** *Gomani (1997, ch. 46 mod.); Buckley et al. (2000, ch. 113 mod.); Pol (2003, ch. 162 mod.); Turner & Buckley (2008, ch. 188 mod.); Andrade et al. (2011, ch. 377); Ristevski et al. (2018, ds 1, ch. 377); Smith et al. (in review, ds 2, ch. 377); Ősi et al. (2018, ds 1, ch. 314).* *This character was modified by Andrade et al. (2011), and here only the main crown is evaluated, not the presence of accessory cusps in cingula. This is considered as a separate character. However, note that states (2) and (3) sample teeth where primary and secondary rows of cusps are present, while in states (0) and (1) there is only one row.* *State (1) occurs in* Malawisuchus*.* *State (2) occurs in* Iharkutosuchus*.* *State (3) occurs in* Edentosuchus *and* Kayentasuchus, *not sampled in this analysis.* 0. each crown has single apical cusp, regardless of presence of accessory cusps in cingula 1. each crown has one main cusp aligned with smaller cusps, arranged in a single row 2. several cusps, unequal in size, arranged in more than one row 3. multiple small cusps, subequal in size, along edges of occlusal surface
321	**Tooth wear, macroscopic wear along the carinae/mesiodistal margins:** *Young et al. (2016, ds 2, ch. 211); Ristevski et al. (2018, ds 2, ch. 275); Smith et al. (in review, ds 1, ch. 280); Ősi et al. (2018, ds 1, ch. 315).* *State (1) is a putative apomorphy of* Dakosaurus + *Mr Leeds dakosaur.* 0. absent 1. present
322	**Anterior–middle dentition, tooth crown curvature:** *Young (2006, ch. 31); Wilkinson et al. (2008, ch. 58); Young & Andrade (2009, ch. 58); Young et al. (2011, ch. 58); Young et al. (2013a, ch. 142); Young et al. (2012, ch. 166); Young (2014, ch. 174); Young et al. (2016, ds 2, ch. 212); Ristevski et al. (2018, ds 2, ch. 276); Smith et al. (in review, ds 1, ch. 281); Ősi et al. (2018, ds 1, ch. 316).* 0. none, crown apical/subapical (between 91 – 89 degrees) 1. weakly recurved (between 88 – 82 degrees) 2. strongly recurved (less than 80 degrees)
323	**Carinae, presence of keel at the edge of tooth crown:** *Young (2006, ch. 29 mod., part); Wilkinson et al. (2008, ch. 55 mod., part); Young & Andrade (2009, ch. 55 mod., part); Andrade et al. (2011, ch. 378); Young et al. (2011, ch. 55 mod., part); Young et al. (2013a, ch. 143 mod., part); Young et al. (2012, ch. 167 mod.); Young (2014, ch. 175); Young et al. (2016, ds 2, ch. 213 mod.); Ristevski et al. (2018, ds 2, ch. 277); Smith et al. (in review, ds 1, ch. 282); Ősi et al. (2018, ds 1, ch. 317).* *Currently, no data suggests differential presence of keels in antero-posterior or upper-lower dentition, therefore a single character is used. Mesial-distal keels may occur independently from denticles in the mesial and distal carinae; denticulated carinae may or may not have keel on denticles.* 0. absent (i.e. lacks keeled carinae) 1. present (i.e. carinated sensu stricto, created by a smooth keel [raised ridge] on the crown edges, typically on the mesial and distal margins)
324	**Carinae, presence of 'carinal flanges': (*)** *Ristevski et al. (2018, ds 2, ch. 278); Smith et al. (in review, ds 1, ch. 283); Ősi et al. (2018, ds 1, ch. 318).* *State (1) occurs in* Plesiosuchus*,* Suchodus *and Mr Leeds Dakosaur*. *State (2) occurs in* Dakosaurus. *This character is not applicable for taxa that lack carinae on all tooth crowns.* 0. absent - the external surfaces of the tooth crowns are still convex/straight when they approach the carinae 1. poorly-developed - the external surface of the tooth crown becomes concave immediately adjacent to the carinae. However, they are unequally expressed on the labial and lingual surfaces, and are rarely expressed along the entire carina

	2. well-developed - the external surface of the tooth crown becomes concave immediately adjacent to the carinae. They are present on both the labial and lingual surfaces, being most noticeably developed at the mid-crown and apex
325	**Carinae, height of the keel in the apical region:** *Ristevski et al. (2018, ds 2, ch. 279); Smith et al. (in review, ds 1, ch. 284); Ősi et al. (2018, ds 1, ch. 319).* *State (1) occurs in* Torvoneustes. 0. keel is either absent, or not greatly enlarged 1. keel is greatly enlarged in height
326	**Carinae, presence of false zipdont serrations at crown edges: (*)** *Young et al. (2011, ch. 172 part); Young et al. (2013a, ch. 144 part); Young et al. (2012, ch. 168 part); Young (2014, ch. 176 part); Young et al. (2016, ds 2, ch. 214 part); Ristevski et al. (2018, ds 2, ch. 280); Smith et al. (in review, ds 1, ch. 285); Ősi et al. (2018, ds 1, ch. 320).* *This character is not applicable for taxa that lack carinae on all tooth crowns.* *False ziphodonty (= conspicuous superficial enamel ornamentation contacting the keel) herein follows the definition described in Prasad & de Lapparent de Broin (2002).* *State (1) occurs in* Theriosuchus pusillus*.* *State (2) occurs in* Goniopholis, Anteophthalmosuchus, Torvoneustes*, and Machimosaurini.* 0. absent across the dentition 1. present, but restricted to the tooth crowns in the posterior end of the tooth row 2. present across the dentition
327	**Carinae, presence and development of true denticles at crown edges: (*)** *Young (2006, ch. 29 part); Wilkinson et al. (2008, ch. 55 part); Young & Andrade (2009, ch. 53 part); Young et al. (2011, ch. 53 part); Young et al. (2012, ch. 169); Young (2014, ch. 177); Young et al. (2016, ds 2, ch. 215); Ristevski et al. (2018, ds 2, ch. 281); Smith et al. (in review, ds 1, ch. 286); Ősi et al. (2018, ds 1, ch. 321).* *In Thalattosuchia, basal geosaurines are scored as state (1).* *Derived genera within Geosaurini are scored as state (2).* *This character is not applicable for taxa that lack carinae on all tooth crowns.* *True ziphodonty herein follows the definition described in Prasad & de Lapparent de Broin (2002).* 0. absent 1. incipient denticles that are poorly defined (hard to discern, in some cases even under Scanning Electron Microscopy). Typically, they either alter the height of the carinal keel very little or not at all (definition described in Young *et al*., 2013) 2. well-defined denticles (can be discerned with or without optical aids)
328	**Carinae (mid-posterior dentition), presence and morphology of denticles at crown edges:** *Buckley et al. (2000, ch. 104 mod.); Sereno et al. (2003, ch. 53 mod.); Andrade & Bertini (2008a, ch. 132 rev.); Andrade et al. (2011, ch. 379 mod. – character states re-ordered); Young et al. (2011, ch. 172 mod.); Young et al. (2013a, ch. 145 mod.); Young et al. (2012, ch. 170 mod.); Young (2014, ch. 178 mod.); Young et al. (2016, ds 2. ch. 216 mod. – new character state added); Ristevski et al. (2018, ds 2, ch. 282); Smith et al. (in review, ds 1, ch. 287); Ősi et al. (2018, ds 1, ch. 322).* *State (1) is putative apomorphy of Notosuchidae + Sphagesauridae.* *In Thalattosuchia, basal geosaurines score as state (2).* *Derived genera within Geosaurini score as state (3).* *Note that this character and the character describing the presence of true denticles appear to correlate. However, the two morphologies are not the same, and it is possible that taxa can score differently for these two characters (i.e., the ziphomorphy condition – see Andrade & Bertini, 2008a).* *Moreover, in Metriorhynchidae the development of the denticles, and whether they form a contiguous row along the carina is highly variable. Some taxa have contiguous and well-defined denticles (e.g.* Dakosaurus*,* Plesiosuchus*,* Geosaurus*) while some taxa have contiguous but incipient denticles (*Torvoneustes*), others non-contiguous incipient denticles (*Tyrannoneustes*,* 'M.' brachyrhynchus*).*

	0. carinae and/or denticles are absent (non-ziphodont), or homogenous carina where serrations may appear as the result of superficial enamel ornamentation (false ziphodont) 1. heterogeneous carina, tubercle-like true denticles that do not form a series (ziphomorph) 2. heterogeneous carina, cuneiform or ripple-like true denticles form short rows of 2–10 denticles and do not proceed contiguously along the entire carina (incipient ziphodont) 3. homogeneous carina, cuneiform or ripple-like true true denticles form a contiguous, or near contiguous, series along the entire carina (ziphodont)
329	**Carinae, true denticle shape when observed in lingual or labial view: (*)** *Young et al. (2012, ch. 171); Young (2014, ch. 179); Young et al. (2016, ds 2, ch. 217); Ristevski et al. (2018, ds 2, ch. 283); Smith et al. (in review, ds 1, ch. 288); Ősi et al. (2018, ds 1, ch. 323).* *In Thalattosuchia, Plesiosuchina (*Plesiosuchus *and* Suchodus*)* are *scored as state (0).* *This character is not applicable for taxa that lack carinae on all tooth crowns, and for those that lack denticles.* 0. "chisel"-shaped or rectangular 1. rounded
330	**Carinae, denticle distribution across the dentition:** *Young et al. (2012, ch. 172); Young (2014, ch. 180); Young et al. (2016, ds 2, ch. 218); Ristevski et al. (2018, ds 2, ch. 284); Smith et al. (in review, ds 1, ch. 289); Ősi et al. (2018, ds 1, ch. 324).* *In Thalattosuchia, state (2) occurs in* Dakosaurus*.* *At present no taxon is known to combine the microziphodont and macroziphodont conditions. However, it is entirely possible that such a taxon could occur. As such, state (3) was created.* *In Thalattosuchia,* Dakosaurus *scores as (2), while* 'Metriorhynchus' brachyrhynchus, Tyrannoneustes lythrodectikos*,* Torvoneustes*,* Geosaurus *and* Plesiosuchus *score as (1).* *Note that this character appears to correlate with the characters describing the incipient/well-developed denticles) and homogeneous/heterogenous carinae. However, these morphologies are not the same, and it is possible that taxa can score differently for these three characters.* *In Metriorhynchidae the development of the macroscopic denticles is a putative apomorphy of* Dakosaurus*, giving this genus macroscopic, well-defined contiguous denticles. In contrast,* Plesiosuchus *and* Geosaurus *have microscopic, well-defined contiguous denticles;* Torvoneustes *has microscopic, incipient contiguous denticles; while* Tyrannoneustes *and* 'M.' brachyrhynchus *have microscopic, incipient, non-contiguous denticles.* *Thus, these three characters are describing a different aspect of denticle development and arrangement.* 0. all or most teeth lack denticles 1. all teeth are microziphodont (*sensu* Andrade *et al*., 2010) 2. all teeth are macroziphodont (*sensu* Andrade *et al*., 2010) 3. teeth show variation in denticle size (with both microziphodonty and macroziphodonty)
331	**Carinae (maxillae), distribution of denticles at crown edges:** *based on Price (1950) and Pol (2003); Andrade & Bertini (2008a, ch. 132 mod.); Andrade et al. (2011, ch. 380); Ristevski et al. (2018, ds 1, ch. 380); Smith et al. (in review, ds 2, ch. 380); Ősi et al. (2018, ds 1, ch. 325).* *This character samples presence of true denticles only, not all serrated carinae or ziphomorph denticles.* *State (1) is putative apomorphy of Notosuchidae + Sphagesauridae (but note that* Adamantinasuchus *and* Mariliasuchus *do not share the character).* 0. mesial and distal crown edges with the same morphology, either with or without true denticles 1. mesial carina absent and distal carina present
332	**Carinae (mid-posterior mandible), distribution of denticles at crown edges:**

	Andrade & Bertini (2008a, ch. 132 mod.); Andrade et al. (2011, ch. 381); Ristevski et al. (2018, ds 1, ch. 381); Smith et al. (in review, ds 2, ch. 381); Ősi et al. (2018, ds 1, ch. 326). *State (1) is putative apomorphy of Sphagesaurus, but unknown in* Armadillosuchus*.* 0. mesial and distal crown edges with the same morphology, either with or without true denticles 1. mesial carina present and distal carina absent, with mid-posterior teeth ocluding as opposing blades
333	**Occlusion, relation between maxillary and dentary series:** *Young et al. (2011, ch. 173); Young et al. (2013a, ch. 146); Young et al. (2012, ch. 173); Young (2014, ch. 181); Young et al. (2016, ds 2, ch. 219); Ristevski et al. (2018, ds 2, ch. 285); Smith et al. (in review, ds 1, ch. 290); Ősi et al. (2018, ds 1, ch. 327).* 0. in-line or interlocked 1. maxillary dentition overbites dentary dentition
334	**Morphology of enamel surface ornamentation, apicobasal ridges:** *Young et al. (2011, ch. 174); Young et al. (2013a, ch. 147); Young et al. (2012, ch. 174 mod.); Young (2014, ch. 182 mod.); Young et al. (2016, ds 2, ch. 220 mod.); Ristevski et al. (2018, ds 2, ch. 286 mod.); Smith et al. (in review, ds 1, ch. 291 mod.); Ősi et al. (2018, ds 1, ch. 328).* *In Thalattosuchia,* Geosaurus*,* Dakosaurus, Rhacheosaurus *and* Cricosaurus *score as state (0).* *State (1) occurs in* Ieldraan melkshamensis*.* *State (2) occurs in* Tyrannoneustes lythrodectikos*.* *State (3) occurs in Mr Leeds dakosaur,* Suchodus durobrivensis, Plesiosuchus manselii*.* *State (4) is the standard, ridged crocodylomorph morphotype.* *State (5) occurs in Mr Passmore's specimen.* 0. enamel ornamentation absent macroscopically (although under SEM microscopic ripples may be present) 1. enamel ornamentation present macroscopically, but largely looks like an enlarged version of the 'rippled' morphology seen under the SEM in 'smooth specimens'. There may also be the occasional poorly defined apicobasal ridge 2. enamel ornamentation largely inconspicuous, being composed of short, well-spaced, well-defined apicobasally aligned ridges on at least the basal half of the crown 3. enamel ornamentation composed of numerous apicobasally aligned ridges that are of low-relief (can only be properly viewed with visual aids), set close to each other, but become shorter and well-spaced towards the carinae 4. enamel ornamentation composed of well-defined apicobasally aligned ridges that are conspicuous and are elongate; being continuous, or having long discontinuous ridges 5. noticeable disparity between the labial and lingual surfaces: lingual surface changes from the standard apicobasal ridge morphology basally, to having shorter ridges which create almost reticulating pattern in the mid-crown region on the lingual surface; on the labial surface, basally the crown is largely smooth, and nearer the mid-crown and up towards the apex the crown is ornamented with numerous short ridges that similarly can make a reticulating pattern
335	**Morphology of apical enamel surface ornamentation, macroscopic anastomosed pattern:** *Young et al. (2012, ch. 175); Young (2014, ch. 183); Young et al. (2016, ds 2, ch. 221); Ristevski et al. (2018, ds 2, ch. 287); Smith et al. (in review, ds 1, ch. 292); Ősi et al. (2018, ds 1, ch. 329).* *State (1) occurs in Machimosaurini* (*e.g.* Machimosaurus, Lemmysuchus), Torvoneustes, *and Goniopholididae (e.g.* Anteophthalmosuchus *and* Goniopholis*).* 0. absent 1. present and strongly developed, but only in the apical region of the crown
336	**Maxillary teeth, occurrence of bilateral paramesial rotation: (ORDERED)** *Pol (2003, ch. 137 mod.); Andrade & Bertini (2008a, ch. 133); Andrade et al. (2011, ch. 414); Ristevski et al. (2018, ds 1, ch. 414); Smith et al. (in review, ds 2, ch. 414); Ősi et al. (2018, ds 1, ch. 330).*

	State (1) occurs in Mariliasuchus *and* Notosuchus*.* *State (2) is a putative apomorphy of Sphagesauridae.* 0. absent 1. bilateral paramesial rotation up to 30 degrees from the original plane 2. bilateral paramesial rotation clearly over 30 degrees from the original plane
337	**Middle and posterior mandibular teeth, occurrence of bilateral paramesial rotation:** *Andrade & Bertini (2008a, ch. 144); Andrade et al. (2011, ch. 415); Ristevski et al. (2018, ds 1, ch. 415); Smith et al. (in review, ds 2, ch. 415); Ősi et al. (2018, ds 1, ch. 331).* *State (2) is a putative apomorphy of Sphagesauridae.* 0. not oblique or slightly altered 1. oblique (more than 30 degrees).
338	**Middle and posterior teeth, presence of cingula with accessory cusps:** *Andrade & Bertini (2008a, ch. 149 mod.); Andrade et al. (2011, ch. 417); Ristevski et al. (2018, ds 1, ch. 417); Smith et al. (in review, ds 2, ch. 417); Ősi et al. (2018, ds 1, ch. 332).* *State (1) occurs in* Candidodon *and* Malawisuchus*.* 0. absent 1. present, cingulum bearing a series small of cusps, set labial/lingual to the main body of crown
339	**Morphology of enamel surface ornamentation, 'pseudodenticles':** *Ristevski et al. (2018, ds 2, ch. 288); Smith et al. (in review, ds 1, ch. 293); Ősi et al. (2018, ds 1, ch. 333).* *State (1) occurs in* Machimosaurus hugii *and* M. rex*. The 'pseudodenticles' are denticle-like structures that occur on the enamel ridges, but not on the carinae.* 0. absent 1. present

Axial post-cranial skeleton (Ch. 338 – 372; 7.174% of characters)

[*Vertebrae (= cervicale, thoracicae, lumbales, sacrales and caudal), costae (= cervicales, thoracicae, sacrales and arcus hæmales)*]

#	Description
340	**Atlas, hypocentrum length:** *Young & Andrade (2009, ch. 122); Young et al. (2011, ch. 122); Young et al. (2013a, ch. 148); Young et al. (2012, ch. 176); Young (2014, ch. 184); Young et al. (2016, ds 2, ch. 222); Ristevski et al. (2018, ds 2, ch. 289); Smith et al. (in review, ds 1, ch. 294); Ősi et al. (2018, ds 1, ch. 334).* 0. long: greater than 15% of odontoid process length 1. short: subequal to odontoid process length (± 5%)
341	**Axis, neural arch diapophysis:** *Young & Andrade (2009, ch. 104); Young et al. (2011, ch. 104); Young et al. (2013a, ch. 149); Young et al. (2012, ch. 177); Young (2014, ch. 185); Young et al. (2016, ds 2, ch. 223); Ristevski et al. (2018, ds 2, ch. 290); Smith et al. (in review, ds 1, ch. 295); Ősi et al. (2018, ds 1, ch. 335).* 0. absent 1. present
342	**Presacral vertebrae number:** *Young & Andrade (2009, ch. 156); Young et al. (2011, ch. 156); Young et al. (2013a, ch. 150); Young et al. (2012, ch. 178); Young (2014, ch. 186); Young et al. (2016, ds 2, ch. 224); Ristevski et al. (2018, ds 2, ch. 291); Smith et al. (in review, ds 1, ch. 296); Ősi et al. (2018, ds 1, ch. 336).* 0. 24 1. 25
343	**Number of cervico-dorsal vertebrae where the parapophyses are borne on the centrum ('cervical vertebrae'), including the atlas-axis:** *Young (2006, ch. 35 mod.); Wilkinson et al. (2008, ch. 63 mod.); Young & Andrade (2009, ch. 63 mod.); Young et al. (2011, ch. 63 mod.); Young et al. (2013a, ch. 151); Young et al. (2012, ch. 179); Young (2014, ch. 187); Young et al. (2016, ds 2,*

	ch. 225); Ristevski et al. (2018, ds 2, ch. 292); Smith et al. (in review, ds 1, ch. 297); Ősi et al. (2018, ds 1, ch. 337). 0. 9 or 10 1. 8 2. 7
344	**Cervical vertebrae, hypapophyses:** *Ristevski et al. (2018, ds 2, ch. 293 mod.); Smith et al. (in review, ds 1, ch. 298 modfied); Ősi et al. (2018, ds 1, ch. 338).* *This character scores the presence of distinct hypapophyses on the ventral surface of the cervical centra.* *State (1) is a putative apomorphy of Thalattosuchia.* 0. present 1. reduced, distinct ventral processes are absent, but a reduced anteroposterior keel is still present
345	**Cervical vertebrae, shape:** *Clark (1994, ch. 92 mod.); Young & Andrade (2009, ch. 145 mod.); Young et al. (2011, ch. 145 mod.); Young et al. (2013a, ch. 152 mod.); Young et al. (2012, ch. 180 mod.); Young (2014, ch. 188 mod.); Young et al. (2016, ds 2, ch. 226); Ristevski et al. (2018, ds 2, ch. 294); Smith et al. (in review, ds 1, ch. 299); Ősi et al. (2018, ds 1, ch. 339).* *Designed to test the homology of repeated procoely evolution in Crocodylomorpha.* *State (2) is occurs in Eusuchia.* 0. amphicoelous or amphyplatian 1. weakly procoelous (i.e. the *Isisfordia* and *Junggarsuchus* morphotype – posterior condyle is poorly developed, with the rim of the posterior face of the centrum still distinct from the convexity of the condyle) 2. strongly procoelous (i.e. the eusuchian morphotype – well-developed posterior condyle, which is formed by the entire posterior face of the centrum)
346	**Posterior cervical vertebrae, centrum length vs centrum width:** *Young (2006, ch. 34); Wilkinson et al. (2008, ch. 62); Young & Andrade (2009, ch. 62); Young et al. (2011, ch. 62); Young et al. (2013a, ch. 153); Young et al. (2012, ch. 181); Young (2014, ch. 189); Young et al. (2016, ds 2, ch. 227); Ristevski et al. (2018, ds 2, ch. 295); Smith et al. (in review, ds 1, ch. 300); Ősi et al. (2018, ds 1, ch. 340).* *State (1) occurs in Geosaurinae.* *State (2) is a putative apomorphy of Metriorhynchidae.* 0. long (centrum length more than 1.5 times the centrum width) 1. moderate (centrum length to width subequal, ± 5%) 2. short (centrum length less than 95% of the centrum width)
347	**Middle cervical vertebrae, neural spine height relative to centrum height:** *Young et al. (2012, ch. 182); Young (2014, ch. 190); Young et al. (2016, ds 2, ch. 228); Ristevski et al. (2018, ds 2, ch. 296); Smith et al. (in review, ds 1, ch. 301); Ősi et al. (2018, ds 1, ch. 341).* *Currently, there is not the information needed to score for most crocodylomorphs. Within Thalattosuchia* Steneosaurus edwardsi *is (0),* St. leedsi *is (1), and metriorhynchids are state (2).* 0. neural spine height is greater than centrum height 1. neural spine and centrum heights are approximately equal 2. neural spine height is less than centrum height
348	**Number of cervico-dorsal vertebrae where the parapophyses are borne partially, or solely, on the neural arch ('thoracic vertebrae'):** *Young et al. (2011, ch. 175); Young et al. (2013a, ch. 154); Young et al. (2012, ch. 183); Young (2014, ch. 191); Young et al. (2016, ds 2, ch. 229); Ristevski et al. (2018, ds 2. ch. 297); Smith et al. (in review, ds 1, ch. 302); Ősi et al. (2018, ds 1, ch. 342).* *This character, (along with the character categorising lumbar vertebrae) was formulated to help understand the regionalisation of the presacral column.* *Currently, there is not the information needed to score for most crocodylomorphs.* 0. 12 1. 13 2. 14

	3. 15
349	**Number of cervico-dorsal vertebrae posterior to the "thoracic vertebrae" and anterior to the sacral vertebrae where the parapophyses are no longer borne on the neural arch ('lumbar vertebrae'):** *Young et al. (2011, ch. 176); Young et al. (2013a, ch. 155); Young et al. (2012, ch. 184); Young (2014, ch. 192); Young et al. (2016, ds 2, ch. 230); Ristevski et al. (2018, ds 2, ch. 298); Smith et al. (in review, ds 1, ch. 303); Ősi et al. (2018, ds 1, ch. 343).* *This character, (along with the character categorising thoracic vertebrae) was formulated to help understand the regionalisation of the presacral column. Currently, there is not the needed information to score for most crocodylomorphs.* 0. 2 1. 3 2. 4
350	**Thoracic and lumbar vertebrae, shape:** *Clark (1994, ch. 93 mod.); Young & Andrade (2009, ch. 146 mod.); Young et al. (2011, ch. 146 mod.); Young et al. (2013a, ch. 156 mod.); Young et al. (2012, ch. 185 mod.); Young (2014, ch. 193 mod.); Young et al. (2016, ds 2, ch. 231); Ristevski et al. (2018, ds 2, ch. 299); Smith et al. (in review, ds 1, ch. 304); Ősi et al. (2018, ds 1, ch. 344).* *State (2) is a putative apomorphy of Eusuchia.* 0. amphicoelous or amphyplatian 1. weakly procoelous (i.e. the *Isisfordia* and *Junggarsuchus* morphotype – posterior condyle is poorly developed, with the rim of the posterior face of the centrum still distinct from the convexity of the condyle) 2. strongly procoelous (i.e. the eusuchian morphotype – well-developed posterior condyle, which is formed by the entire posterior face of the centrum)
351	**Thoracic vertebrae, shallow fossa on the anterior margin of the diapophysis immediately lateral to the parapophysis:** *Young & Andrade (2009, ch. 165); Young et al. (2011, ch. 165); Young et al. (2013a, ch. 157); Young et al. (2012, ch. 186 mod.); Young (2014, ch. 194); Young et al. (2016, ds 2, ch. 232); Ristevski et al. (2018, ds 2, ch. 300); Smith et al. (in review, ds 1, ch. 305); Ősi et al. (2018, ds 1, ch. 345).* *State (1) is a putative apomorphy of Metriorhynchidae, best observed in thoracic vertebrae mid-to-late in the series.* 0. present 1. absent
352	**Thoracic vertebrae, orientation of parapophysis:** *Young & Andrade (2009, ch. 166); Young et al. (2011, ch. 166); Young et al. (2013a, ch. 158); Young et al. (2012, ch. 187); Young (2014, ch. 195); Young et al. (2016, ds 2, ch. 233); Ristevski et al. (2018, ds 2, ch. 301); Smith et al. (in review, ds 1, ch. 306); Ősi et al. (2018, ds 1, ch. 346).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. posteriorly or horizontally 1. anteriorly
353	**Anterior thoracic vertebrae, parapophysis in relation to the diapophysis:** *Young et al. (2012, ch. 188); Young (2014, ch. 196); Young et al. (2016, ds 2, ch. 234); Ristevski et al. (2018, ds 2, ch. 302); Smith et al. (in review, ds 1, ch. 307); Ősi et al. (2018, ds 1, ch. 347).* *Currently, there is not the information needed to score for most crocodylomorphs. Within Thalattosuchia,* Steneosaurus edwardsi *and* St. leedsi *are state (0), and metriorhynchids score as state (1).* 0. parapophysis ventral to, or level with, diapophysis (when observed in lateral view) 1. parapophysis dorsal to diapophysis (when observed in lateral view)
354	**Anterior thoracic vertebrae, neural spine height relative to centrum height:** *Young et al. (2012, ch. 189); Young (2014, ch. 197); Young et al. (2016, ds 2, ch. 235); Ristevski et al. (2018, ds 2, ch. 303); Smith et al. (in review, ds 1, ch. 308); Ősi et al. (2018, ds 1, ch. 348).* *Currently, there is not the needed information to score for most crocodylomorphs. Within Thalattosuchia,* Machimosaurus mosae *and* Steneosaurus edwardsi *are state (0), and* St. leedsi *and metriorhynchids score as state (1).*

	0. neural spine and centrum heights are approximately equal 1. neural spine height is less than centrum height
355	**Dorsal vertebrae, shape and relative positions of the neural spines: (NEW)** *State (1) is a putative apomorphy of* Cricosaurus suevicus *(based on the lectotype and all referred specimens from the Nusplingen Plattenkalk).* 0. neural spines have the 'normal' shape – elongated, dorsal margin convex to weakly convex, and the neural spines of adjacent dorsals clearly separated from one another 1. neural spines are all rectangular when seen in lateral view, a flat dorsal margin is most prevalent, and the neural spines of adjacent dorsal vertebrae are very close to one another
356	**Sacral vertebra, number (= sacralisation of the first caudal vertebra):** *Buscalioni & Sanz (1988, ch. 44 mod.); Pol & Apesteguia (2005, ch. 115 mod.); Andrade et al. (2011, ch. 432); Ristevski et al. (2018, ds 2, ch. 304); Smith et al. (in review, ds 1, ch. 309); Ősi et al. (2018, ds 1, ch. 349).* *The number of sacral vertebrae can be increased by the addition of last dorsal/lumbar or the first caudal, which constitute two divergent conditions, both leading to the total number of three sacral vertebrae (R. M. Santucci, pers. comm. 2004). Andrade et al. (2011) modified this character from the original to reflect this problem, although only the latter condition (addition of first caudal) has been reported so far (see for example, description in Pol 2005: p. 7-8). Note that the fusion of sacrals observed in* Alligatorellus *and* Montsecosuchus *(1st+2nd sacrals) is not homologous to the one reported by Pol (2005) for* Notosuchus *(2nd sacral+1st caudal).* *This character scores for a similar character as: Nesbitt (2011, ch. 207); Young et al. (2013a, ch. 159); Young et al. (2012, ch. 190); Young (2014, ch. 198); Young et al. (2016, ds 2, ch. 236). However, those characters referred to an "insertion" of a sacral vertebra between the first and second primordial sacral vertebrae.* *This character scores for the "third" sacral found in certain taxa (e.g.* Machimosaurus, Notosuchus, Mariliasuchus *and* Baurusuchus*).* *Within Thalattosuchia, evidence for three sacral vertebrae is found in Machimosaurini (*Lemmysuchus *and* Machimosaurus*).* 0. two 1. three, with the third being the first caudal vertebra
357	**Sacral vertebrae, shape of centra posterior face:** *Young (2014, ch. 199); Young et al. (2016, ds 2, ch. 237); Ristevski et al. (2018, ds 2, ch. 305); Smith et al. (in review, ds 1, ch. 310); Ősi et al. (2018, ds 1, ch. 350).* *State (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* *Note that this character has a wider distribution than Young (2014) and Young et al. (2016, ds 2) thought (i.e. not restricted to Geosaurini).* 0. circular to sub-circular, with- or without an equatorial bulge 1. distinctly oval, transverse width noticeably greater than dorsoventral height
358	**Caudal vertebra, shape of caudal vertebra 1:** *Ristevski et al. (2018, ds 2, ch. 306); Smith et al. (in review, ds 1, ch. 311); Ősi et al. (2018, ds 1, ch. 351).* *Character based on Clark (1994, ch. 94).* *State (1) occurs in* Theriosuchus, *bernissartids and eusuchians.* 0. amphicoelous or amphyplatian 1. biconvex 2. procoelous
359	**Caudal vertebra, shape of the caudal vertebrae posterior to the first caudal:** *Ristevski et al. (2018, ds 2, ch. 307); Smith et al. (in review, ds 1, ch. 312); Ősi et al. (2018, ds 1, ch. 352).* *Character based on Clark (1994, ch. 94).* 0. all are amphicoelous or amphyplatian 1. mixture of semi-procoelous, amphicoelous or amphyplatian

	2. all are procoelous
360	**Caudal vertebrae, number:** *Young (2006, ch. 36 mod.); Wilkinson et al. (2008, ch. 64); Young & Andrade (2009, ch. 64); Young et al. (2011, ch. 64); Young et al. (2013a, ch. 160); Young et al. (2012, ch. 191); Young (2014, ch. 200); Young et al. (2016, ds 2, ch. 239); Ristevski et al. (2018, ds 2, ch. 308); Smith et al. (in review, ds 1, ch. 313); Ősi et al. (2018, ds 1, ch. 353).* 0. less than 46 1. 50 or more
361	**Caudal vertebrae, relative height of neural spine:** *Andrade et al. (2011, ch. 435); Ristevski et al. (2018, ds 2, ch. 309); Smith et al. (in review, ds 1, ch. 314); Ősi et al. (2018, ds 1, ch. 354).* *State (1) occurs in Dyrosauridae.* 0. larger spines are up to 2.5 times the height of vertebral body 1. spines are typically 2.5–4 times the height of vertebral body
362	**Caudal vertebrae, shape and orientation of the neural spines immediately in front of the flexural caudal vertebrae: (NEW) (*) (ORDERED)** *State (1) occurs in* Gracilineustes*.* *State (2) occurs in* Rhacheosaurus *and* Cricosaurus*.* *This character is not applicable for taxa that do not have a 'tail fluke'.* 0. the neural spines are largely similar in shape to the other preflexural caudal vertebrae, although with some slight posterior orientation 1. the neural spines of the vertebrae immediately in front of the tail bend have a distinct morphology: the are dorsoventrally low, strongly inclined posteriorly such that the tips of the neural spines are slightly dorsal to the immediately posterior centrum 2. 1. the neural spines of the five-to-six vertebrae immediately in front of the tail bend have a distinct morphology: the are dorsoventrally very low, strongly inclined posteriorly such that the tips of the neural spines are clearly dorsal to the immediately posterior centrum
363	**Caudal vertebrae, abrupt change in centrum cross-section at the distal end of the column:** *Andrade et al. (2011, ch. 436 part); Young et al. (2013a, ch. 161 part); Young et al. (2012, ch. 192 part); Young (2014, ch. 201 part); Young et al. (2016, ds 2, ch. 240 part); Ristevski et al. (2018, ds 2, ch. 310 part); Smith et al. (in review, ds 1, ch. 315 part); Ősi et al. (2018, ds 1, ch. 355).* *State (1) is a putative apomorphy of Metriorhynchidae, but also occurs in* Magyarosuchus fitosi*. This suggests this character may have a wider distribution in Metriorhynchoidea.* *This character is an osteological correlate relating to the increase in distal tail lateral surface area. In taxa with a tail fin, this shape change is seen in both 'flexural', and post-flexural caudal vertebrae.* *All the characters relating to the tail fin morphological complex are present in known metriorhynchids; however, in plesiosaurians the presence of these characters is variable between taxa, with no taxon having all the character states (Smith, 2013). Moreover, ichthyosaurs also show a gradual evolution of the tail bend and fin (see Motani, 2005). It is likely the morphological adaptations for a tail fin evolved in a mosaic manner in basal metriorhynchoids as well.* *This character helps score the modification of the distal caudal vertebrae into a hypocercal tail.* 0. centra retain a sub-circular to sub-oval cross-section the same as, or similar to, that seen in proximal caudal vertebrae (i.e. the caudal vertebrae are isomorphic or poorly heteromorphic) 1. abrupt change in centrum shape, with strong mediolateral compression (distal vertebrae are clearly heteromorphic)
364	**Caudal vertebrae, shift in neural spine inclination near distal end:** *Andrade et al. (2011, ch. 436 part); Young et al. (2013a, ch. 161 part); Young et al. (2012, ch. 192 part); Young (2014, ch. 201 part); Young et al. (2016, ds 2, ch. 240 part); Ristevski et al. (2018, ds 2, ch. 310 part); Smith et al. (in review, ds 1, ch. 315 part); Ősi et al. (2018, ds 1, ch. 356).* *State (1) is a putative apomorphy of Metriorhynchidae.*

	The neural spines of the distal caudal vertebrae are unknown in Magyarosuchus fitosi*.* *This character is an osteological correlate for a soft tissue structure along the dorsal margin of the distal tail, as the thickening and re-orientation of the neural spines support this structure. However, this structure need not be very large (i.e. a true upper lobe of a hypocercal tail).* *All the characters relating to the tail fin morphological complex are present in known metriorhynchids; however, in plesiosaurians the presence of these characters is variable between taxa, with no taxon having all the character states (Smith, 2013). Moreover, ichthyosaurs also show a gradual evolution of the tail bend and fin (see Motani, 2005). It is likely the morphological adaptations for a tail fin evolved in a mosaic manner in basal metriorhynchoids as well.* *This character helps score the modification of the distal caudal vertebrae into a hypocercal tail.* 0. no, distal caudal vertebral neural spines do not have a shift in orientation (being sub-vertical and/or posteriorly inclinded) 1. yes, there is a distinct region of the distal caudal vertebrae that have a shift in neural spine orientation, changing from: a posterior inclination, to being sub-vertical, to having an anterior inclination
365	**Caudal vertebrae, ventral deflection of the distal end: (ORDERED)** *Young (2006, ch. 33 part); Wilkinson et al. (2008, ch. 61 part); Young & Andrade (2009, ch. 61 part); Young et al. (2011, ch. 61 part); Ősi et al. (2018, ds 1, ch. 357). State (2) is a putative apomorphy of Metriorhynchidae.* *The presence of a ventral deflection of the distal caudal vertebrae is unknown in* Magyarosuchus fitosi*.* *This character helps define the lower lobe of a hypocercal tail. Note that in ichthyosaurs (Motani, 2005), the presence of a ventral deflection does not always mean there would have been a true upper lobe.* *All the characters relating to the tail fin morphological complex are present in known metriorhynchids; however, in plesiosaurians the presence of these characters is variable between taxa, with no taxon having all the character states (Smith, 2013). Moreover, ichthyosaurs also show a gradual evolution of the tail bend and fin (see Motani, 2005). It is likely the morphological adaptations for a tail fin evolved in a mosaic manner in basal metriorhynchoids as well.* *This character helps score the modification of the distal caudal vertebrae into a hypocercal tail.* *Note, most preserved metriorhynchid tails give an exaggerated angle, either due to how the vertebrae have been arranged (in disarticulated specimens) or the vertebrae are not fully in* in vivo *conditions (for specimens preserved in limestone). The* in vivo *condition is shown by retaining the curvature of the post-flexural caudal vertebrae.* *Note that juvenile specimens cannot be used to score this character (e.g.* Rhacheosaurus gracilis*) as there may be an ontogenetic increase in the angle, such as in ichthyosaurs.* 0. absent 1. present, tail bend angle is less than 10 degrees 2. present, tail bend angle is between 10-40 degrees 3. present, tail bend angle is greater than 40 degrees

366	**Caudal vertebrae, number of vertebrae involved in the tail deflection:** *Ősi et al. (2018, ds 1, ch. 358).* *State (2) is a putative apomorphy of Metriorhynchidae.* *The presence of a ventral deflection of the distal caudal vertebrae is unknown in* Magyarosuchus fitosi*.* *This character helps define the lower lobe of a hypocercal tail. Note that in ichthyosaurs (Motani, 2005) the abruptness of the caudal series deflection varies between basal and derived clades, and in mosasaurids the tail bend is spread out across multiple vertebrae, similarly to basal ichthyosaurs (Lindgren et al. 2008, 2010). Therefore, a multi-state was created here to accommodate potential basal metriorhynchoids with a tail bend spread across a high number of caudal vertebrae. This character helps score the modification of the distal caudal vertebrae into a hypocercal tail.* *Note that juvenile specimens cannot be used to score this character (e.g.* Rhacheosaurus gracilis*) as there may be an ontogenetic increase in the angle, such as in ichthyosaurs.* 0. no ventral deflection of the distal caudal series 1. deflection is large, occurring over 15 to 30 vertebrae 2. deflection is abrupt, occurring over 5 to 10 vertebrae
367	**Caudal vertebrae, rapid centrum anteroposterior length reduction in postflexural caudal vertebrae: (NEW) (*)** *State (1) occurs in* Cricosaurus *sp*. *This character is not applicable for taxa that do not have a 'tail fluke'.* 0. the centra become progressively 'smaller' in anteroposterior length and dorsoventral height as the neural arches regress 1. the centra rapidly become 'smaller' as the neural arches regress
368	**Axis rib:** *Young et al. (2012, ch. 193); Young (2014, ch. 202); Young et al. (2016, ds 2, ch. 241); Ristevski et al. (2018, ds 2, ch. 311); Smith et al. (in review, ds 1, ch. 316); Ősi et al. (2018, ds 1, ch. 359).* *State (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* *Callovian teleosaurids have a distinct 'bump' or 'process' where a second articular head would be (see Andrews, 1913). However, in no specimen is there a second articular head preserved.* 0. holocephalous (rib elongate, with one articular head) 1. dichocephalous (rib triradiate, with two articular heads)
369	**Axis rib, tuberculum:** *Young & Andrade (2009, ch. 149); Young et al. (2011, ch. 149); Young et al. (2013a, ch. 162); Young et al. (2012, ch. 194); Young (2014, ch. 203); Young et al. (2016, ds 2, ch. 242); Ristevski et al. (2018, ds 2, ch. 312); Smith et al. (in review, ds 1, ch. 317); Ősi et al. (2018, ds 1, ch. 360).* 0. wide with broad dorsal tip 1. narrow with acute dorsal tip
370	**Atlantal ribs, presence of very thin medial laminae at anterior end:** *Brochu (1999, ch. 16); Andrade et al. (2011, ch. 437); Ristevski et al. (2018, ds 1, ch. 437); Smith et al. (in review, ds 2, ch. 437); Ősi et al. (2018, ds 1, ch. 361).* *State (1) is a putative apomorphy of Caimaninae.* 0. absent 1. present
371	**Sacral vertebrae, relative position of lateral end of the transverse processes (= sacral ribs): (ORDERED)** *Young (2006, ch. 53 + 54); Wilkinson et al. (2008, ch. 81 + 82); Young & Andrade (2009, ch. 81 + 82); Andrade et al. (2011, ch. 433 + 434); Young et al. (2011, ch. 81 + 82); Young et al. (2013a, ch. 163 + 164); Young et al. (2012, ch. 195 + 196); Young (2014, ch. 204 + 205); Young et al. (2016, ds 2, ch. 243 + 244); Ristevski et al. (2018, ds 2, ch. 313); Smith et al. (in review, ds 2, ch. 318); Ősi et al. (2018, ds 1, ch. 362).* *In Thalattosuchia the first sacral (as often the second) has its transverse processes at least poorly arched ventrally (see Andrews, 1913). In* Pelagosaurus typus *and metriorhynchids the transverse processes are strongly arched ventrally projecting the head for head contact with the ilium below the level of the cervical centrum (1),*

	contrasting with teleosaurids (e.g., Steneosaurus*). However, in* Pelagosaurus typus*, the transverse processes are not as slender and does not project as ventrally.* *States (1+2) occur in Thalattosuchia.* *State (1) occurs in teleosauroids.* *State (2) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* 0. level with the vertebral centrum 1. transverse processes of sacral vertebra one lateroventrally directed, ventral relative to the vertebral centrum 2. transverse processes of both sacral vertebrae are lateroventrally directed, ventral relative to the vertebral centrum. In these taxa, the lateral ends of the transverse processes of both sacral vertebrae are typically significantly ventrally arched.
372	**Chevrons (= haemal arches), shape near the distal end of the caudal series:** *Young & Andrade (2009, ch. 164 mod.); Young et al. (2011, ch. 164 mod.); Young et al. (2013a, ch. 165 mod.); Young et al. (2012, ch. 197 mod.); Young (2014, ch. 206 mod.); Young et al. (2016, ds 2, ch. 245 mod.); Ristevski et al. (2018, ds 2, ch. 314 mod.); Smith et al. (in review, ds 1, ch. 319 mod.); Ősi et al. (2018, ds 1, ch. 363).* *State (1) is a putative apomorphy of Metriorhynchidae.* *The distal chevrons are unknown in* Magyarosuchus fitosi. *This character defines the change to the chevrons that stiffen the distal tail (seen ventral to 'flexural' and anterior post-flexural vertebrae).* *All the characters relating to the tail fin morphological complex are present in known metriorhynchids; however, in plesiosaurians the presence of these characters is variable between taxa, with no taxon having all the character states (Smith, 2013). Moreover, ichthyosaurs also show a gradual evolution of the tail bend and fin (see Motani, 2005). It is likely the morphological adaptations for a tail fin evolved in a mosaic manner in basal metriorhynchoids as well.* *This character helps score the modification of the distal tail into a tail fin.* 0. in lateral view they are either sub-triangular in shape or rod-like, in anterior view they are either 'V' or 'Y' shaped 1. in lateral view the main body of the chevron is mediolaterally compressed, deepening it dorsoventrally. In anterior view, some chevrons will have a slight 'W' shape, created by the midline anterior process being oriented anterodorsally
373	**Chevrons (= haemal arches), presence of a notch on the ventral margin of the distal chevrons:** *Ősi et al. (2018, ds 1, ch. 364).* *State (1) is a putative apomorphy of* Metriorhynchus superciliosus. *However, note few metriorhynchids are known to preserve all/most of the flexural and postflexural chevrons. All studied metriorhynchid specimens preserved in limestone from the Late Jurassic of Germany lack these notches.* *This character can only be scored if there are multiple distal chevrons preserved, and they have the complete ventral margin.* 0. absent 1. present
374	**Chevrons (= haemal arches), nature of contact in distal chevrons: (NEW)** *State (1) occurs in* Cricosaurus suevicus *and* C. sp. *However, note few metriorhynchids are known to preserve all/most of the flexural and postflexural chevrons.* *This character can only be scored if there are multiple distal chevrons preserved, and they have the complete anterior and posterior margins.* 0. if adjacent chevrons contact, they do so along their posterior-anterior margins 1. adjacent chevrons contact along the posteroventral-anterodorsal margins

Appendicular skeleton: pectoral girdle and forelimbs (Ch. 373 – 395; 5.000% of characters)

[pectoral elements (ossa coracoidea & ossa scapula); stylopodia (ossa humeri), zeugopodia (ossa radii & ossa ulnae), autopodia (ossa radialia/ulnaria, ossa metacarpalia, & ossa digitorum manus)]

#	Description

375	**Coracoid, shape:** *Young (2006, ch. 40); Wilkinson et al. (2008, ch. 69); Young & Andrade (2009, ch. 69); Young et al. (2011, ch. 69); Young et al. (2013a, ch. 166); Young et al. (2012, ch. 198); Young (2014, ch. 207); Young et al. (2016, ds 2, ch. 246); Ristevski et al. (2018, ds 2, ch. 315); Smith et al. (in review, ds 1, ch. 320); Ősi et al. (2018, ds 1, ch. 365).* *State (1) occurs in teleosauroids.* *State (2) occurs in Metriorhynchoidea.* 0. neither proximal (i.e. glenoid region) nor distal (i.e. postglenoid process) ends are fan-shaped, having angular margins 1. distal end convex, forming a gentle fan-shape while the proximal end is triangular in shape with blunt ends 2. both proximal and distal ends are convex
376	**Coracoid, postglenoid process:** *Nesbitt (2011, ch. 223); Young et al. (2016, ds 2, ch. 247); Ristevski et al. (2018, ds 2, ch. 316); Smith et al. (in review, ds 1, ch. 321); Ősi et al. (2018, ds 1, ch. 366).* *State (0) occurs in non-crocodylomorphs.* *State (1) occurs in 'sphenosuchians'.* *Sstate (2) is a putative apomorphy of Crocodyliformes.* 0. short 1. elongate and expanded posteriorly only 2. elongate and expanded anteriorly and posteriorly
377	**Coracoid, posteroventral edge, deep groove:** *Nesbitt (2011, ch. 224); Young et al. (2016, ds 2, ch. 248); Ristevski et al. (2018, ds 2, ch. 317); Smith et al. (in review, ds 1, ch. 322); Ősi et al. (2018, ds 1, ch. 367).* *State (1) occurs in Rauisuchiae and most 'sphenosuchians'.* 0. absent 1. present
378	**Scapula blade:** *Young et al. (2012, ch. 199 mod.); Young (2014, ch. 208, mod.); Young et al. (2016, ds 2, ch. 249 mod.); Ristevski et al. (2018, ds 2, ch. 318 mod.); Smith et al. (in review, ds 1, ch. 323 mod.); Ősi et al. (2018, ds 1, ch. 368).* *State (1) is a putative apomorphy of Teleosauroidea.* *State (2) is a putative apomorphy of Metriorhynchidae.* 0. scapula blade large: approximately twice the width of the scapular shaft, and generally wider than the distal glenoid region 1. scapula blade reduced: being as wide as, or narrower than, the glenoid region; and the scapular blade is less than 1.5 times the width of the scapular shaft. 2. scapula blade reduced: blade broadens both anteriorly and posteriorly, but is still as wide as, or narrower than, the glenoid region.
379	**Scapula, anterior and posterior margins in lateral aspect:** *Young & Andrade (2009, ch. 105 mod.); Young et al. (2011, ch. 105 mod.); Young et al. (2013a, ch. 167 mod.); Young et al. (2012, ch. 200); Young (2014, ch. 209); Young et al. (2016, ds 2, ch. 250); Ristevski et al. (2018, ds 2, ch. 319); Smith et al. (in review, ds 1, ch. 324); Ősi et al. (2018, ds 1, ch. 369).* 0. symmetrically concave in lateral view 1. anterior edge more strongly concave than posterior edge 2. posterior edge more strongly concave than anterior edge
380	**Scapula, deltoid crest:** *Young & Andrade (2009, ch. 106); Young et al. (2011, ch. 106); Young et al. (2013a, ch. 168); Young et al. (2012, ch. 201); Young (2014, ch. 210); Young et al. (2016, ds 2, ch. 251); Ristevski et al. (2018, ds 2, ch. 320); Smith et al. (in review, ds 1, ch. 325); Ősi et al. (2018, ds 1, ch. 370).* 0. present 1. absent
381	**Scapula/Humerus, size:** *Young (2006, ch. 39); Wilkinson et al. (2008, ch. 68); Young & Andrade (2009, ch. 68); Young et al. (2011, ch. 68); Young et al. (2013a, ch. 169); Young et al. (2012, ch. 202); Young (2014, ch. 211); Young et al. (2016, ds 2, ch. 252); Ristevski et al. (2018, ds 2, ch. 321); Smith et al. (in review, ds 1, ch. 326); Ősi et al. (2018, ds 1, ch. 371).*

	0. humerus longer than scapula (greater than 15%) 1. humerus and scapula subequal in length (± 13%) 2. humerus shorter in length than scapula (less than 15%)
382	**Limb bones (forelimbs), proportional length of ulna relative to the humerus: (ORDERED)** *Andrade et al. (2011, ch. 452); Ristevski et al. (2018, ds 2, ch. 322); Smith et al. (in review, ds 1, ch. 327); Ősi et al. (2018, ds 1, ch. 372).* *State (2) is a putative apomorphy of Thalattosuchia (not Teleosauridae as putatively put forward by Andrade et al., 2011).* *In Thalattosuchia the ulna is typically between 48%–72% of the length of the humerus (perhaps being longer in juvenile specimens).* *State (2) also occurs in the* Pachycheilosuchus + Pietraroiasuchus *clade.* 0. ulna clearly longer than humerus 1. ulna subequal to humerus (distal/proximal = 75–125%) 2. ulna clearly shorter than the humerus
383	**Humerus, proximal region:** *Nesbitt (2011, ch. 232 mod.); Young et al. (2013a, ch. 170); Young et al. (2012, ch. 203 mod.); Young (2014, ch. 212); Young et al. (2016, ds 2, ch. 253 - added state 2); Ristevski et al. (2018, ds 2, ch. 323); Smith et al. (in review, ds 1, ch. 328); Ősi et al. (2018, ds 1, ch. 373).* *In Thalattosuchia, derived teleosaurids (*Aeolodon priscus, S. bollensis, S. leedsi, S. edwardsi*) have state (2) - the posterior deflection being much more pronounced than in other thalattosuchians.* *In Geosaurini and Rhacheosaurini taxa change to state (0).* 0. confined to the proximal surface 1. posteriorly expanded and hooked 2. very strongly posteriorly deflected and hooked, with the proximal epiphysis noticeably posterior to the distal epiphysis
384	**Humerus, proximomedial articular surface:** *Young & Andrade (2009, ch. 107); Young et al. (2011, ch. 107); Young et al. (2013a, ch. 171); Young et al. (2012, ch. 204); Young (2014, ch. 213); Young et al. (2016, ds 2, ch. 254); Ristevski et al. (2018, ds 2, ch. 324); Smith et al. (in review, ds 1, ch. 329); Ősi et al. (2018, ds 1, ch. 374).* *State (1) occurs in* Rhacheosaurus *and* Cricosaurus*.* 0. strongly convex 1. weakly convex
385	**Humerus, deltopectoral crest:** *Young (2006, ch. 38 modfied); Wilkinson et al. (2008, ch. 66 mod.); Young & Andrade (2009, ch. 66 mod.); Young et al. (2011, ch. 66 mod.); Young et al. (2013a, ch. 172); Young et al. (2012, ch. 205); Young (2014, ch. 214); Young et al. (2016, ds 2, ch. 255); Ristevski et al. (2018, ds 2, ch. 325); Smith et al. (in review, ds 1, ch. 330); Ősi et al. (2018, ds 1, ch. 375).* *State (1) is a putative apomorphy of Metriorhynchidae.* *Young et al. (2013a) removed state (2) (absent/vestigial) as metriorhynchids of the subclade Rhacheosaurini do indeed have a deltopectoral crest on their humeri.* 0. present and distinct from the proximal surface 1. present, but continuous with the proximal surface
386	**Humerus, shape:** *Young et al. (2012, ch. 206); Young (2014, ch. 215); Young et al. (2016, ds 2, ch. 256); Ristevski et al. (2018, ds 2, ch. 326); Smith et al. (in review, ds 1, ch. 331); Ősi et al. (2018, ds 1, ch. 376).* *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. has typical long bone morphology (longer than wide at distal end) 1. broadly expanded and plate-like
387	**Humerus, length of the diaphysis relative to total humerus length:** *Wilkinson et al. (2008, ch. 67); Young & Andrade (2009, ch. 67); Young et al. (2011, ch. 67); Young et al. (2013a, ch. 173); Young et al. (2012, ch. 207); Young (2014, ch. 216); Young et al. (2016, ds 2, ch. 257); Ristevski et al. (2018, ds 2, ch. 327); Smith et al. (in review, ds 1, ch. 332); Ősi et al. (2018, ds 1, ch. 377).*

	This character quantifies the reduction in humeral shaft size in Metriorhynchidae. This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae. 0. diaphysis contributing more than 50% of total humeral length 1. diaphysis contributes 35–38% of total humeral length 2. diaphysis contributes less than 25% of total humeral length
388	**Humerus-antebrachium joint surface:** *Young et al. (2011, ch. 180); Young et al. (2013a, ch. 174); Young et al. (2012, ch. 208); Young (2014, ch. 217); Young et al. (2016, ds 2, ch. 258); Ristevski et al. (2018, ds 2, ch. 328); Smith et al. (in review, ds 1, ch. 333); Ősi et al. (2018, ds 1, ch. 378).* *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. complex, allowing one degree of motion – i.e. the humeral epiphyses are ossified 1. planar, limiting possible motion – i.e. the humeral epiphyses are unossified
389	**Radius and/or ulna, shape:** *Young (2006, ch. 37); Wilkinson et al. (2008, ch. 65); Young & Andrade (2009, ch. 65); Young et al. (2011, ch. 65 + 176); Young et al. (2013a, ch. 175 + 177); Young et al. (2012, ch. 209 + 211); Young (2014, ch. 218 + 220); Young et al. (2016, ds 2, ch. 259 + 261); Ristevski et al. (2018, ds 2, ch. 329); Smith et al. (in review, ds 1, ch. 334); Ősi et al. (2018, ds 1, ch. 379).* *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. typical long bone morphology (proximodistal length noticeably greater than width at distal end) 1. broadly expanded and plate-like
390	**Ulna, axis length:** *Ősi et al. (2018, ds 1, ch. 380).* *State (1) is a putative apomorphy of Rhacheosaurini.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. the proximodistal axis length of the ulna is greater than the length of the anteroposterior axis 1. the anteroposterior axis length of the ulna is greater than the length of the proximodistal axis
391	**Ulna, morphology of olecranon process:** *Brochu (1999, ch. 27); Turner & Buckley (2008, ch. 260); Andrade et al. (2011, ch. 457); Ristevski et al. (2018, ds 1, ch. 459); Smith et al. (in review, ds 2, ch. 459); Ősi et al. (2018, ds 1, ch. 381).* 0. narrow and subangular 1. wide and rounded
392	**Ulna, olecranon process mediolaterally compressed and greatly expanded, creating a very broad proximal ulna:** *Ősi et al. (2018, ds 1, ch. 382).* *State (1) occurs in derived teleosaurids.* *Basal teleosauroids (such as* Platysuchus multiscorbiculatus *and* Steneosaurus bollensis*) score as (0).* 0. no 1. yes
393	**Radiale and/or ulnare, shape:** *Young et al. (2011, ch. 177 + 179); Young et al. (2013a, ch. 176 + 178); Young et al. (2012, ch. 210 + 212); Young (2014, ch. 219 + 221); Young et al. (2016, ds 2, ch. 260 + 262); Ristevski et al. (2018, ds 2, ch. 330); Smith et al. (in review, ds 1, ch. 335); Ősi et al. (2018, ds 1, ch. 383).* *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. typical long bone morphology (proximodistal length noticeably greater than width at distal end)

	1. broadly expanded and plate-like
394	**Manus, metacarpal general structure: (*)** *Buscalioni (2017, ch. 424 mod., part); Ősi et al. (2018, ds 1, ch. 384).* *Ősi et al. (2018) modified the character from Buscalioni (2017) to help quantify the manus morphological changes occurring at the transition from basal crocodyliforms to metasuchians. Here it samples overall robustness, not relative length.* *This character is not applicable for taxa that do not have all five manual digits.* 0. metacarpals IV and V not strongly differentiated from II-III in terms of overall robusticity 1. metacarpals II-III are noticeably more robust than those of IV-V (due to metacarpal I being greatly enlarged relative to all other metacarpals in some clades, it is not used in this character)
395	**Manus, shape of metacarpal I: (*)** *Young (2006, ch. 41); Wilkinson et al. (2008, ch. 70); Young & Andrade (2009, ch. 70); Young et al. (2011, ch. 70); Young et al. (2013a, ch. 179); Young et al. (2012, ch. 213); Young (2014, ch. 222); Young et al. (2016, ds 2, ch. 263); Ristevski et al. (2018, ds 2, ch. 331); Smith et al. (in review, ds 1, ch. 336); Ősi et al. (2018, ds 1, ch. 385).* *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* *This character is not applicable for taxa that lack digit I.* 0. elongate, more than twice as long as wide 1. broadly expanded, maximum width at least 60% of total length
396	**Manus, digit I:** *Ősi et al. (2018, ds 1, ch. 386).* *State (1) is a putative apomorphy of* Junggarsuchus*.* *This character helps score the modification of the manus into being functionally tridactyl.* 0. present 1. absent
397	**Manus, relative length of digit V: (*)** *Buscalioni (2017, ch. 424 mod., part); Ősi et al. (2018, ds 1, ch. 387).* *Ősi et al. (2018) modified the character from Buscalioni (2017) to help quantify the manus morphological changes occurring at transition from basal crocodyliforms to metasuchians.* *This character is not applicable for taxa that do not have all five manual digits.* 0. digit V longer than digit I, being comparable in length to digits II-IV 1. digit V reduced in length, being evidently shorter than digits II-IV and comparable in length to digit I

Appendicular skeleton: pelvic girdle and hind limbs (Ch. 396 – 432; 8.043% of characters)

[pelvic elements (ossa pubes, ossa ilia, & ossa ischia); stylopodia (ossa femora), zeugopodia (ossa tibiae), autopodia (ossa calcis, ossa metatarsalia, & ossa digitorum pedis)]

#	Description
398	**Pubis, exclusion from acetabulum:** *Turner & Sertich (2010, ch. 86 part); Andrade et al. (2011, ch. 445); Young et al. (2013a, ch. 180 part); Young et al. (2012, ch. 214 part); Young (2014, ch. 223 part); Young et al. (2016, ds 2, ch. 264 part); Ristevski et al. (2018, ds 2, ch. 332); Smith et al. (in review, ds 1, ch. 337); Ősi et al. (2018, ds 1, ch. 388).* *Following Claesson (2004) state (1) occurs in Crocodyliformes.* *This character scores the pubis articulation with the acetabulum (state 0), and the mobile pubis articulating with the ischium anterior process (state 1).* 0. pubis not excluded, participating at least marginally to the anteroventral rim of the acetabulum 1. pubis excluded, acetabulum composed exclusively by the ischium and illium
399	**Pubis, presence of exclusive proximal contact with ischium:**

	Andrade et al. (2011, ch. 446) – based on Andrews (1913) and Clark (1994, ch. 86); Ristevski et al. (2018, ds 2, ch. 333); Smith et al. (in review, ds 1, ch. 338); Ősi et al. (2018, ds 1, ch. 389). *Note that in Metasuchia this character correlates with the pubic exclusion from the acetabulum; however, thalattosuchians also have the pubis excluded from the acetabulum, but the pubis articulates between the ischium pubic process and the ilium anterior peduncle.* 0. absent, pubis supported by both ilium and ischium 1. present, proximal head of pubis contacts only the ischium
400	**Pubis, length:** *Nesbitt (2011, ch. 278); Young et al. (2016, ds 2, ch. 265); Ristevski et al. (2018, ds 2, ch. 334); Smith et al. (in review, ds 1, ch. 339); Ősi et al. (2018, ds 1, ch. 390).* *State (0) is a putative apomorphy of Crocodyliformes.* 0. less than 70% of femoral length 1. 70% or more of femoral length
401	**Pubis, expansion of distal end** *Clark (1994, ch. 85 mod.); Andrade et al. (2011, ch. 447 mod.); Nesbitt (2011, ch. 283 mod.); Ristevski et al. (2018, ds 2, ch. 335); Smith et al. (in review, ds 1, ch. 340); Ősi et al. (2018, ds 1, ch. 391).* *Note that* Postosuchus *has a pubic boot (along with other non-crocodylomorph pseudosuchians; Nesbitt, 2011; Weinbaum, 2013). Here we test the homology of this pubic boot with that seen in crocodylomorphs (the* Protosuchus *distal expansion, and the 'fan'-like pubic blade seen in other crocodyliforms). Nesbitt (2011) reports that a small posterior expansion is present in the holotype of* Hesperosuchus agilis*, suggesting the lack of an expansion in* Terristrisuchus *is apomorphic.* *State (2) is a putative apomorphy of Mesoeucrocodylia.* 0. absent 1. expanded relative to the shaft (= pubic boot) 2. a "fan-like" expansion creating a distinct pubic blade
402	**Pubis, presence of an obturator foramen:** *Leardi et al. (2017, ch. 126); Ősi et al. (2018, ds 1, ch. 392).* *State (1) occurs in Crocodyliformes.* 0. present 1. absent
403	**Ilium, presence of a distinct anterior acetabular flange, created by the anterior acetabular margin projecting anteriorly such that it is anterior to the iliac anterior margin:** *Smith et al. (in review, ds 1, ch. 341); Ősi et al. (2018, ds 1, ch. 393).* *State (1) occurs in basal metriorhynchoids*. *Note, this condition is different from that of* Dyrosaurus maghribensis*, as there the entire anterior margin of the ilium bulges anteriorly, not just the acetabular margin (which in* Pelagosaurus typus *creates the thin acetabular flange).* 0. absent 1. present
404	**Ilium, relative length of anterior and posterior processes: (*)** *Clark (1994, ch. 84); Lauprasert et al. (2007, ch. 68); Andrade et al. (2011, ch. 441); Ristevski et al. (2018, ds 1, ch. 441); Smith et al. (in review, ds 2, ch. 441); Ősi et al. (2018, ds 1, ch. 394).* *This character is not applicable for taxa that lack the posterior process of the ilium.* 0. subequal, anterior and posterior processes similar in length 1. unequal, with anterior process relatively small, one quarter or less than the length of the posterior process
405	**Ilium, presence of indentation at the dorsal margin of iliac blade:** *Brochu (1999, ch. 28 mod., part); Andrade et al. (2011, ch. 442); Ristevski et al. (2018, ds 1, ch. 442); Smith et al. (in review, ds 2, ch. 442); Ősi et al. (2018, ds 1, ch. 395).* *Andrade et al. (2011) divded this character to separate diverse aspects of the morphology of the anterior end of iliac blade. This character samples the indentation at the dorsal edge of the anterior process.* 0. absent, dorsal edge convex or straight in lateral view

	1. present as a shallow or modest dorsal indentation 2. present as a strong dorsal indentation (“wasp-waisted”)
406	**Ium, presence of a distinct 'bulge' that fuses the anterior regions of the supraacetabular and dorsal iliac crests: (*)** *Ristevski et al. (2018, ds 2, ch. 336); Smith et al. (in review, ds 1, ch. 342); Ősi et al. (in review, ds 1, ch. 396).* *State (1) occurs in* Anteophthalmosuchus hooleyi *and* Crocodylus. *This character is not applicable for taxa that lack the dorsal iliac crest.* 0. anterior region of the supraacetabular crest does not fuse with the anterior margin of the iliac dorsal crest, as there is no anterior ‘bulge’ 1. anterior region of the crest bulges laterally (slightly overhanging the acetabular fossa), and is contiguous with the anterior margin of the iliac dorsal crest
407	**Ilium, postacetabular (= posterior) process presence:** *Young & Andrade (2009, ch. 128 mod.), Young et al. (2011, ch. 128 mod.); Young et al. (2013a, ch. 181 mod.); Young et al. (2012, ch. 215 mod.); Young (2014, ch. 224); Wilberg (2015b, ch. 368); Young et al. (2016, ds 2, ch. 266 mod.); Ristevski et al. (2018, ds 2, ch. 337); Smith et al. (in review, ds 1, ch. 343); Ősi et al. (2018, ds 1, ch. 397).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. present 1. absent/extremely reduced
408	**Ilium, postacetabular (= posterior) process expanded into a thin “fan”-shape: (*)** *Young et al. (2012, ch. 216); Young (2014, ch. 225); Wilberg (2015b, ch. 369); Young et al. (2016, ds 2, ch. 267); Ristevski et al. (2018, ds 2, ch. 338); Smith et al. (in review, ds 1, ch. 344); Ősi et al. (2018, ds 1, ch. 398).* *State (1) is a putative apomorphy of derived teleosauroids (not seen in basal taxa* Platysuchus multiscrobiculatus, Teleosaurus cadomensis, Steneosaurus gracilirostris *and* S. bollensis *where the process is still elongate and distinctly process-like). This structure is a modification of the postacetabular (=posterior) process in these taxa.* *This character is not applicable for taxa that lack the postacetabular process.* 0. no 1.yes, posterior margin is expanded (typically resembling a “fan”-shape), being mediolaterally compressed and extends from the iliac crest towards the posterior peduncle
409	**Ilium, postacetabular (= posterior) process, presence of constrictions (‘wasp-waisting’) on both the dorsal and ventral margins near the distal terminus: (*)** *Ristevski et al. (2018, ds 2, ch. 339); Smith et al. (in review, ds 1, ch. 345); Ősi et al. (2018, ds 1, ch. 399).* *State (1) occurs in* Anteophthalmosuchus epikrator *and* Crocodylus. *This character is not applicable for taxa that lack the postacetabular process.* 0. absent 1. present
410	**Illium, size:** *Young (2006, ch. 42); Wilkinson et al. (2008, ch. 71); Young & Andrade (2009, ch. 71); Young et al. (2011, ch. 71); Young et al. (2013a, ch. 182); Young et al. (2012, ch. 217); Young (2014, ch. 226); Young et al. (2016, ds 2, ch. 268); Ristevski et al. (2018, ds 2, ch. 340); Smith et al. (in review, ds 1, ch. 346); Ősi et al. (2018, ds 1, ch. 400).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. large (length of dorsal border more than 28%, and typically at least 30% of femur length) 1. small (length of dorsal border less than 21% of femur length)
411	**Ilium, in lateral view, the orientation of the dorsal margin of the articulation facet that contributes to the acetabulum is:** *Young (2014, ch. 227); Young et al. (2016, ds 2, ch. 269); Ristevski et al. (2018, ds 2, ch. 341); Smith et al. (in review, ds 1, ch. 347); Ősi et al. (in review, ds 1, ch. 401).* *State (1) is a putative autapomorphy of* Tyrannoneustes lythdrodectikos. 0. ventrally orientated

	1. horizontally orientated
412	**Ilium, dorsal border length in lateral view:** *Young (2014, ch. 228); Young et al. (2016, ds 2, ch. 270); Ristevski et al. (2018, ds 2, ch. 342); Smith et al. (in review, ds 1, ch. 348); Ősi et al. (2018, ds 1, ch. 402).* *State (1) is a putative autapomorphy of* Tyrannoneustes lythdrodectikos. 0. long, terminates at least level to the articulation facet that contributes to the acetabulum 1. short, terminates prior to the articulation facet that contributes to the acetabulum
413	**Ilium, ventral margin:** *Ristevski et al. (2018, ds 2, ch. 343); Smith et al. (in review, ds 1, ch. 349); Ősi et al. (2018, ds 1, ch. 403).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. distinct ilium and ischium peduncles separated by an acetabular incision/depression 1. lacks an acetabular depression, with the peduncles being contiguous with the ventral margin
414	**Ischium, presence of pubic (= anterior) process:** *Andrade et al. (2011, ch. 444) – reformulated from Clark (1994, ch. 86) and Andrews (1913); Ristevski et al. (2018, ds 1, ch. 446); Smith et al. (in review, ds 2, ch. 446); Ősi et al. (2018, ds 1, ch. 404).* 0. pubic process absent, or incipient and small, not restricting the participation of the pubis to the acetabulum 1. anterior process well developed, robust and with a round head, at least partially restricting the participation of pubis in the acetabulum
415	**Ischium, morphology of pubic (= anterior) process: (*)** *Young (2006, ch. 43); Wilkinson et al. (2008, ch. 72); Young & Andrade (2009, ch. 72); Young et al. (2011, ch. 72); Young et al. (2013a, ch. 183); Young et al. (2012, ch. 218); Young (2014, ch. 229); Young et al. (2016, ds 2, ch. 271); Ristevski et al. (2018, ds 2, ch. 344); Smith et al. (in review, ds 1, ch. 350); Ősi et al. (2018, ds 1, ch. 405).* *State (1) is a putative apormorphy of Metriorhynchidae.* *State (2) is a putative apomorphy of* Cricosaurus. *This character is not applicable for taxa that lack, or have incipient pubic processes.* 0. developed – with clearly defined articulation facets for pubis and ilium; additionally, anterior process is at least half as wide as the posterior process 1. reduced – lacks both articulation facets, and is between 30–50% as wide as the posterior process 2. highly reduced – lacking both articulation facets, and is less than 25% as wide as the posterior process
416	**Ischium, morphology of anterior process of iliac blade, in lateral view:** *Brochu (1999, ch. 28 mod., part); Andrade et al. (2011, ch. 443); Ristevski et al. (2018, ds 1, ch. 443); Smith et al. (in review, ds 2, ch. 443); Ősi et al. (2018, ds 1, ch. 406).* *Andrade et al. (2011) divded this character to separate diverse aspects of the morphology of the anterior end of iliac blade. This character samples the morphology of the anterior process. Among eusuchians, state (1) is a somewhat generalised condition; state (0) is putative apomorphy of* Paleosuchus*; and state (2) is putative apomorphy of* Diplocynodon. 0. very narrow relative the main body of the iliac blade 1. rounded and moderately broad relative the main body of the iliac blade 2. very broad and deep, at least half the height of the main body of the iliac blade
417	**Limb bones, length relative to trunk, at maturity: (ORDERED)** *Brochu (1999, ch. 33 mod.); Andrade et al. (2011, ch. 448); Ristevski et al. (2018, ds 1, ch. 450); Smith et al. (in review, ds 2, ch. 450); Ősi et al. (2018, ds 1, ch. 407).* *Andrade et al. (2011) modified this character to sample length relative to trunk, not overall robustness.* *Within Eusuchia, Brochu (1999) considers that state (2) only occurs in* Borealosuchus. 0. limb bones relatively short 1. limb bones moderately long 2. limb bones very long

418	**Limb bones, general structure:** *Brochu (1999, ch. 33 part); Andrade et al. (2011, ch. 449); Ristevski et al. (2018, ds 1, ch. 451); Smith et al. (in review, ds 2, ch. 451); Ősi et al. (2018, ds 1, ch. 408). Andrade et al. (2011) modified this character was to sample overall robustness, not relative length. Within Eusuchia, Brochu (1999) considers that state (2) only occurs in* Borealosuchus*.* 0. limb bones robust 1. limb bones overall slender, but not weak 2. gracile
419	**Limb bones, relative length of forelimbs/hindlimbs (= *humerus* + *radius* : *femur* + *tibia*):** *Brochu (1999, ch. 33 part); Young & Andrade (2009, ch. 109 mod.); Andrade et al. (2011, ch. 450 mod.); Nesbitt (2011, ch. 212 mod.); Young et al. (2011, ch. 109 mod.); Young et al. (2013a, ch. 195 mod.); Young et al. (2012, ch. 230 mod.); Young (2014, ch. 241 mod.); Young et al. (2016, ds 2, ch. 284 mod.); Ristevski et al. (2018, ds 2, ch. 345); Smith et al. (in review, ds 1, ch. 351); Ősi et al. (2018, ds 1, ch. 409).* *Andrade et al. (2011) modified the crocodylomorph variant of this character to sample relative length of limbs, not robustness or limb/trunk relative length. This version of the character is an amalgam of the ones in Andrade et al. (2011) and Nesbitt (2011), the latter which Young et al. (2016, ds 2) modified to include extra states to reflect the forelimb reduction in Thalattosuchia.* *This character does not consider the autopodia (manus and pes), only the relation between the stylopodia and zeugopodia (humerus + ulna and femur + tibia, respectively).* *States (3 + 4) reflects the extreme conditions found in Thalattosuchia. State (4) evolved twice, once in Metriorhynchidae, and also in derived teleosauroids (the Middle Jurassic '*Steneosaurus*' clade).* *Note that basal thalattosuchians (e.g.* Steneosaurus bollensis, Platysuchus multiscrobiculatus *and* Pelagosaurus typus*) have state (2).* *State (2) also occurs in* Gavialis *and* Terminonaris*.* *State (3) also evolved in the* Pachycheilosuchus + Pietraroiasuchus *clade.* *Basal crocodylomorphs also share state (2), while state (3) occurs in* Postosuchus*.* *Within Eusuchia, Brochu (1999) considers that state (0) only occurs in* Borealosuchus*.* 0. forelimb and hindlimb subequal in length at maturity 1. forelimb slightly shorter than hindlimb at maturity 2. forelimb shorter than hindlimb at maturirty (between 90 and 55%) 3. forelimb noticeably shorter than hindlimb at maturity (between 45 and 55%) 4. forelimb significantly shorter than hindlimb at maturity (less than 45%)
420	**Limb bones (hindlimbs), proportional length of tibia relative to the femur: (ORDERED)** *Clark et al. (2000, ch. 31 mod.); Clark & Sues (2002, ch. 32 mod.); Sues et al. (2003, ch. 32 mod.); Clark et al. (2004, ch. 32 mod.); Young (2006, ch. 44 mod.); Wilkinson et al. (2008, ch. 73 mod.); Young & Andrade (2009, ch. 73 mod.); Andrade et al. (2011, ch. 453 mod.); Young et al. (2012, ch. 225 + 231 mod.); Pol et al. (2013, ch. 32 mod.); Young et al. (2016, ds 2, ch. 278 mod.); Leardi et al. (2017, ch. 32 mod.); Ristevski et al. (2018, ds 1, ch. 455 mod.); Smith et al. (in review, ds 2, ch. 455 mod.); Ősi et al. (2018, ds 1, ch. 410).* *This version of the character is an amalgam of the ones in Andrade et al. (2011), Young et al. (2016) and Leardi et al. (2017).* *This character is designed to help elucidate variation in the proportions of the hind limb, and the changes that occur in Thalattosuchia (where the femur can be almost twice the size of tibia, i.e. in Metriorhynchidae). Thus states (2-5) are putative apomorphies of Thalattosuchia.* *State (0) occurs in* Terrestrisuchus, *Hallopodidae, and* Gobiosuchus*.* *In Thalattosuchia, state (4) is a putative apomorphy of both Metriorhynchinae and* Aeolodon priscus*, with derived metriorhynchines being state (5). Middle Jurassic teleosauroids (and the Late Jurassic genus* Machimosaurus*) and Geosaurinae score as state (3).* *Thus, this character is scoring for the independent regression of the tibia (as a proportion of the hind limb) in Teleosauroidea and Metriorhynchidae.*

	State (2) also occurs in Dyrosauridae and Terminonaris. 0. length uneven, tibia slightly longer than the femur (distal/proximal more than 105%) 1. tibia subequal to femur, or only slightly shorter (distal/proximal c. 75-100%) 2. length uneven, tibia evidently shorter than the femur (distal/proximal c. 50-74%) 3. length uneven, tibia evidently shorter than the femur (distal/proximal c. 40-50%) 4. length uneven, tibia evidently shorter than the femur (distal/proximal c. 30-40%) 5. length uneven, tibia evidently shorter than the femur (distal/proximal less than 30%)
421	**Femur, relative orientation between the proximal and distal heads:** *Ortega et al. (2000, ch. 149), Andrade et al. (2011, ch. 455); Ristevski et al. (2018, ds 1, ch. 457); Smith et al. (in review, ds 2, ch. 457); Ősi et al. (2018, ds 1, ch. 411).* 0. femur with light torsion, proximal and distal articulation facets approximately at 30 degrees or less from each other 1. femur with evident torsion, proximal and distal articulation facets approximately at 60 degrees from each other
422	**Femur, general shape:** *Andrade et al. (2011, ch. 464 mod.); Ristevski et al. (2018, ds 2, ch. 347 mod.); Smith et al. (in review, ds 1, ch. 353 mod.); Ősi et al. (2018, ds 1, ch. 412).* *State (1) is a putative apomorphy of Thalattosuchia.* 0. sigmoidal shape formed by either an unequal proximal and distal curvature, or a strong sigmoidal shape 1. sigmoidal shape formed by comparable curvatures proximally and distally, and forms a shallow 'S'-shape
423	**Femur, proximal portion, posteromedial tuber:** *Nesbitt (2011, ch. 301 mod. – character states re-ordered); Young et al. (2013a, ch. 184); Young et al. (2012, ch. 219); Young (2014, ch. 230); Young et al. (2016, ds 2, ch. 272); Ristevski et al. (2018, ds 2, ch. 348); Smith et al. (in review, ds 1, ch. 354); Ősi et al. (2018, ds 1, ch. 413).* *State (2) is a putative apomorphy of Metriorhynchoidea.* *State (2) also occurs in non-paracrocodylomorph pseudosuchians.* 0. absent 1. present, and small 2. present, and largest of the proximal tubera
424	**Femur, proximal condylar fold:** *Nesbitt (2011, ch. 312); Young et al. (2013a, ch. 185); Young et al. (2012, ch. 220); Young (2014, ch. 231); Young et al. (2016, ds 2, ch. 273); Ristevski et al. (2018, ds 2, ch. 349); Smith et al. (in review, ds 1, ch. 355); Ősi et al. (2018, ds 1, ch. 414).* *State (1) occurs in Paracrocodylomorpha.* *The proximal condylar fold is a straight ridge that connects the medioventral portion of the ventral head with the shaft on the anterolateral surface of the femur (Nesbitt 2011: p. 149).* *Note that this fold can be hard to discern in Metriorhynchidae. It is possible that derived species of* Cricosaurus *lack this fold.* 0. absent 1. present
425	**Femur, ridge of attachment for the *M. caudofemoralis*:** *Young & Andrade (2009, ch. 108 mod.); Nesbitt (2011, ch. 315 mod.); Young et al. (2011, ch. 108 mod.); Young et al. (2013a, ch. 186); Young et al. (2012, ch. 221); Young (2014, ch. 232); Young et al. (2016, ds 2, ch. 274); Ristevski et al. (2018, ds 2, ch. 350); Smith et al. (in review, ds 1, ch. 356); Ősi et al. (2018, ds 1, ch. 415).* *We follow Young et al. (2016, ds 2) in scoring thalattosuchians as state (0). Thalattosuchians lack a fourth trochanter sensu stricto, as they only have a large flattened rugose area for the muscle attachment, not a distinct process. Thus state (0) is a putative apomorphy of Thalattosuchia.* 0. absent, flattened rugose area 1. low and without a distinct medial asymmetrical apex (= fourth trochanter) 2. bladelike with a distinct asymmetric apex located medially
426	**Lateral edge of proximal articular surface of femur (lesser trochanter):** *Young & Andrade (2009, ch. 117); Young et al. (2011, ch. 117); Young et al. (2013a, ch. 187); Young et al. (2012, ch. 222); Young (2014, ch. 233); Young et al.*

	(2016, ds 2, ch. 275); Ristevski et al. (2018, ds 2, ch. 351); Smith et al. (in review, ds 1, ch. 357); Ősi et al. (2018, ds 1, ch. 416). *State (1) occurs in Metasuchia.* 0. rounded 1. 'squared' with enlarged scar for *Musculus ischiotrochantericus*
427	**Femur, medial condyle of the distal portion:** *Nesbitt (2011, ch. 320 mod.); Young et al. (2013a, ch. 188 mod.); Young et al. (2012, ch. 223 mod.); Young (2014, ch. 234 mod.); Young et al. (2016, ds 2, ch. 276 mod.); Ristevski et al. (2018, ds 2, ch. 352 mod.); Smith et al. (in review, ds 1, ch. 358); Ősi et al. (2018, ds 1, ch. 417).* *State (0) occurs in basal pseudosuchians.* *State (1) occurs in Postosuchidae + Crocodylomorpha.* *State (2) occurs in Metriorhynchidae.* 0. tapers to a point on the medial portion in distal view 1. smoothly rounded in distal view 2. condyle incompletely ossified, and typically poorly developed
428	**Femur, distal surface between the lateral and medial condyles:** *Nesbitt (2011, ch. 321); Young et al. (2013a, ch. 189); Young et al. (2012, ch. 224); Young (2014, ch. 235); Young et al. (2016, ds 2, ch. 277); Ristevski et al. (2018, ds 2, ch. 353); Smith et al. (in review, ds 1, ch. 359); Ősi et al. (2018, ds 1, ch. 418).* *State (1) occurs in crocodyliforms, and some 'sphenosuchians'.* *Within Crocodyliformes, state (0) is a putative apomorphy of Metriorhynchidae.* 0. nearly flat or flat 1. groove separating the medial condyle from the lateral condyle
429	**Calcaneum tuber, development:** *Young (2006, ch. 45 mod.); Wilkinson et al. (2008, ch. 74 mod.); Young & Andrade (2009, ch. 74 mod.); Andrade et al. (2011, ch. 466); Young et al. (2011, ch. 74 mod.); Young et al. (2013a, ch. 191 mod.); Young et al. (2012, ch. 226 mod.); Young (2014, ch. 237 mod.); Young et al. (2016, ds 2, ch. 279 - rephrased); Ristevski et al. (2018, ds 2, ch. 354); Smith et al. (in review, ds 1, ch. 360); Ősi et al. (2018, ds 1, ch. 419).* *This character scores the regression of the tuber in metriorhynchines. Whether the calcaneal tuber regresses in geosaurine metriorhynchids is currently unknown.* 0. well developed with a long neck (typically subequal in length to main body of calcaneum) 1. poorly developed with a short neck (less than half length of calcaneum main body, and projects out in one plane from the calcaneum main body)
430	**Pes, length of metatarsals: (ORDERED)** *Young (2006, ch. 46 mod.); Wilkinson et al. (2008, ch. 75 mod.); Young & Andrade (2009, ch. 75 mod.); Young et al. (2011, ch. 75 mod.); Young et al. (2013a, ch. 192 mod.); Young et al. (2012, ch. 227 mod.); Young (2014, ch. 238 mod.); Young et al. (2016, ds 2, ch. 280 mod.); Ristevski et al. (2018, ds 2, ch. 355 mod.); Smith et al. (in review, ds 1, ch. 361 mod.); Ősi et al. (2018, ds 1, ch. 420).* *States (1-2) occur in Metriorhynchoidea.* *State (2) occurs in Metriorhynchidae.* *This character helps score the modification of the pes into paddles in Metriorhynchoidea.* 0. metatarsals I–IV longer than their repective digit phalanges (greater than 20%) 1. metatarsals II–IV sub-equal in length to their repspective digit phalanges (± 10%) 2. metatarsals II–IV shorter than their respective digit phalanges (less than 90%)
431	**Pes, proximal morphology of metatarsal I: (ORDERED)** *Young (2006, ch. 47 mod.); Wilkinson et al. (2008, ch. 76 mod.); Young & Andrade (2009, ch. 76 mod.); Andrade et al. (2011, ch. 467 mod.); Young et al. (2011, ch. 76 mod.); Young et al. (2013a, ch. 193 mod.); Young et al. (2012, ch. 228 mod.); Young (2014, ch. 239 mod.); Young et al. (2016, ds 2, ch. 281 mod.); Ristevski et al. (2018, ds 2, ch. 356 mod.); Smith et al. (in review, ds 1, ch. 362 mod.); Ősi et al. (2018, ds 1, ch. 421).* *States (1-3) occur in Metriorhynchoidea.* *This character scores the broadening of metatarsal I seen in metriorhynchines. The pes of geosaurine metriorhynchid is currently unknown.*

	This character helps score the modification of the pes into paddles in Metriorhynchoidea. 0. proximal end not enlarged (typically no more than 10%, but depending on preservation up to 20%, wider than any other metatarsal) 1. proximal end enlarged (25-30% wider) 2. proximal end moderately enlarged (45-55% wider) 3. proximal end greatly enlarged (more than 75% wider)
432	**Pes, relative length of digits III and IV:** *Young (2006, ch. 48); Wilkinson et al. (2008, ch. 77); Young & Andrade (2009, ch. 77); Andrade et al. (2011, ch. 465); Young et al. (2011, ch. 77); Young et al. (2013a, ch. 194); Young et al. (2012, ch. 229); Young (2014, ch. 240); Young et al. (2016, ds 2, ch. 283); Ristevski et al. (2018, ds 2, ch. 357); Smith et al. (in review, ds 1, ch. 363); Ősi et al. (2018, ds 1, ch. 422).* *In crocodyliforms, the digits are usually in the following descending order: III-IV-II-I. State (1) is putative apomorphy of Metriorhynchoidea, and with digit length arranged as IV-III-II-I (see Young & Andrade 2009, Appendix 2). Previously this has been considered to be a metriorhynchid apomorphy.* *This character helps score the modification of the pes into paddles in Metriorhynchoidea.* 0. digit III is longer than digit IV 1. digit IV is longer than digit III (digit IV elongated, helping to create a paddle)
433	**Pes, digit IV, number of phalanges: (ORDERED)** *Nesbitt (2011, ch. 396 mod.); Ristevski et al. (2018, ds 2, ch. 358); Smith et al. (in review, ds 1, ch. 364); Ősi et al. (2018, ds 1, ch. 423).* *State (0) is a putative apomorphy of* Postosuchus*.* *State (1) occurs in most archosauriforms.* *State (2) is a putative apomorphy of Crocodylomorpha.* *Ristevski et al. (2018, ds 2) added state (0) as six pedal digit IV phalanges have been reported for specimens of* P. alisonae *Peyer et al. (2008) and* P. kirkpatricki *(Weinbaum, 2013).* 0. six 1. five 2. four or fewer
434	**Pes, digit V, metatarsals and phalanges:** *Clark (1994, ch. 88 mod.); Nesbitt (2011, ch. 399 re-phrased); Young et al. (2016, ds 2, ch. 282); Ristevski et al. (2018, ds 2, ch. 359); Smith et al. (in review, ds 1, ch. 365); Ősi et al. (2018, ds 1, ch. 424).* *State (0) occurs in non-crocodylomorphs.* *State (1) occurs in 'sphenosuchians'.* *State (2) is a putative apomorphy of Crocodyliformes.* 0. present and "fully" developed first phalanx 1. present and "poorly" developed first phalanx 2. without phalanges and metatarsal tapers to a point

Dermal ossifications: osteoderms (Ch. 433 – 456; 5.217% of characters)

#	Description
435	**Ornamentation (dorsal osteoderms), type of sculpture: (*)** *Ortega et al. (2000, ch. 111); Andrade et al. (2011, ch. 19); Ristevski et al. (2018, ds 2, ch. 360); Smith et al. (in review, ds 1, ch. 366); Ősi et al. (2018, ds 1, ch. 425).* *Ornamentation on the osteoderms is always present, and only in two possible forms. Note that Turner & Buckley (2008) considered that* Araripesuchus gomesii *and (possibly)* A. tsangatsangana *displayed the 'fleur de lys' pattern (anterolaterally and anteromedially directed "ridges"; Osmólska et al., 1997), according to the character by Pol & Norell (2004b, ch188). We consider that this pattern regards the disposition of the sculpturing (fabric), not the type of sculpturing.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. vermiform-dendritic pattern 1. pitted pattern
436	**Ornamentation (dorsal osteoderms), distribution of pits on dorsal surface: (*)**

	Young et al. (2011, ch. 185 mod.); Young et al. (2013a, ch. 201 mod.); Young et al. (2012, ch. 239 mod.); Young (2014, ch. 250 mod.); Young et al. (2016, ds 2, ch. 297 mod.); Ristevski et al. (2018, ds 2, ch. 361 mod.); Smith et al. (in review, ds 1, ch. 367); Ősi et al. (2018, ds 1, ch. 426). *State (2) is a putative autapomorphy of* Magyarosuchus fitosi*.* *State (3) is a putative apomorphy of Machimosaurini*. *Ősi et al. (2018) added state (2) to accommsueviodate the unusual osteoderm pit morphology seen in* Magyarosuchus fitosi*.* *This character is not applicable for taxa that lack dorsal osteoderms, or pitted ornamentation.* 0. small round to ellipsoid pits, very densely distributed 1. large round to ellipsoid pits, well separated from one another 2. irregularly shaped pits (including circular, ellipsoid, bean-shaped, triangular and quadrangular shapes), with an extreme variation in size (from small to very large), with elongate pits present on the ventrolateral surface running from the keel to the lateral margin 3. pits variable in size and length, from small to large, but on osteoderms with a keel, the pits can become elongate grooves, especially along the lateral margins
437	**Presacral osteoderms, dorsal to the vertebral column:** *Clark (1994, ch. 100 mod.); Brochu (1999, ch. 39 part); Young (2006, ch. 51); Wilkinson et al. (2008, ch. 80); Young & Andrade (2009, ch. 80); Andrade et al. (2011, ch. 468 part); Nesbitt (2011, ch. 401); Young et al. (2011, ch. 80); Young et al. (2013a, ch. 196 part); Young et al. (2012, ch. 232 part); Young (2014, ch. 243 part); Wilberg (2015b, ch. 382); Young et al. (2016, ds 2, ch. 285); Wilberg (2017, ch. 394); Ristevski et al. (2018, ds 2, ch. 362); Smith et al. (in review, ds 1, ch. 368); Ősi et al. (2018, ds 1, ch. 427).* *State (0) occurs in* Junggarsuchus *and Metriorhynchidae.* 0. absent 1. present
438	**Presacral ventral osteoderms (= gastral osteoderms), form a carapace in the trunk region:** *Young (2006, ch. 50 mod.); Wilkinson et al. (2008, ch. 79 mod.); Young & Andrade (2009, ch. 79 mod.); Andrade et al. (2011, ch. 468 part); Nesbitt (2011, ch. 409 re-phrased); Young et al. (2011, ch. 79 mod.); Young et al. (2013a, ch. 199); Young et al. (2012, ch. 236 mod.); Young (2014, ch. 247 mod.); Young et al. (2016, ds 2, ch. 294); Ristevski et al. (2018, ds 2, ch. 374); Smith et al. (in review, ds 1, ch. 380); Ősi et al. (2018, ds 1, ch. 428).* *Crocodyliformes have state (1), although with reversions.* 0. absent 1. present
439	**Nuchal armour, relation of nuchal osteoderms with the remaining dorsal armour and skull: (*)** *Brochu (1999, ch. 38 mod., part); Andrade et al. (2011, ch. 469); Ristevski et al. (2018, ds 2, ch. 363); Smith et al. (in review, ds 1, ch. 369); Ősi et al. (2018, ds 1, ch. 429).* *Note that a similar character was devised by Ortega et al. (2000, ch. 109), but to unite the undescribed Itaborai form and* Sebecus*. See also McAliley et al. (2006) for discussion on eusuchians*. *This character is not applicable for taxa that lack dorsal osteoderms.* 0. large nuchal shields continuous from postoccipital region to trunk armour, with any given osteoderm contacting the anterior and posterior elements (except for the first postoccipital shield) 1. large nuchal shields continuous with trunk armour, but not reaching the postoccipital region 2. large nuchal shields discontinuous with dorsal trunk armour and absent from postoccipital region
440	**Nuchal armour, number and arrangement of nuchal shields: (*)** *Brochu (1999, ch. 38 mod. & rev. in part); Andrade et al. (2011, ch. 470); Ristevski et al. (2018, ds 2, ch. 364); Smith et al. (in review, ds 1, ch. 370); Ősi et al. (2018, ds 1, ch. 430).*

	State (3), and the terminology 'cervical shield' is according to Marinho & Carvalho (2009). See also McAliley et al. (2006) for discussion on eusuchians. *This character is not applicable for taxa that lack dorsal osteoderms, or that lack a distinct nuchal shield (i.e. thalattosuchians).* 0. four paramedian nuchal shields, sided by two accessory shields, all enlarged relative to the remaining neck dermal armour 1. four paramedian nuchal shields enlarged relative to remaining neck shields, and no accessory shield enlarged 2. eight (or more) shields, arranged in two paramedian rows, enlarged relative to remaining neck shields, with no accessory shield enlarged 3. ten or more median osteoderms, combined with several lateral osteoderms, composing a distinct cervical shield
441	**Nuchal armour, morphology of nuchal shields relative to the remaining trunk dermal armour: (*)** *Brochu (1999, ch. 38 mod. in part); Andrade et al. (2011, ch. 471); Ristevski et al. (2018, ds 2, ch. 365); Smith et al. (in review, ds 1, ch. 371); Ősi et al. (2018, ds 1, ch. 431).* *State (1) occurs in* Armadilosuchus *and Susisuchidae + Eusuchia (with a reversal in gavialoids).* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. nuchal and dorsal trunk shields undifferentiated, morphology grading continuously 1. nuchal shields clearly differentiated from dorsal trunk shields by size and general morphology (regardless of contact between nuchal and trunk series)
442	**Presacral dorsal armour, presence of an anterior process (= anterolateral process, = stylofoveal process) to articulate with the anterior adjacent osteoderm, in medial dorsal elements: (*)** *Norell & Clark (1990, ch. 13 rev.); Clark (1994, ch. 96 mod.); Brochu (1999, ch. 40 rev.); Ortega et al. (2000, ch. 113 rev.); Andrade et al. (2011, ch. 477 mod.); Young et al. (2011, ch. 184); Young et al. (2013a, ch. 198); Young et al. (2012, ch. 233 mod.); Young (2014, ch. 244); Young et al. (2016, ds 2, ch. 286); Ristevski et al. (2018, ds 1, ch. 483; ds 2, ch. 366 mod.); Smith et al. (in review, ds 1, ch. 372 mod.; ds 2, ch. 483 mod.); Ősi et al. (2018, ds 1, ch. 432).* *Scores for a similar morphology as Nesbitt (2011, ch. 403).* *Note that this process does not include the lateral processes seen in dyrosaurids, as they articulate with the accessory osteoderms.* *State (2) is a putative apomorphy of* Magyarosuchus fitosi. *Ősi et al. (2018) modified this character by adding state (2), which is a modification of the distinct 'peg-like' anterolateral process seen in* Magyarosuchus fitosi. *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent 1. present, as a distinct 'peg-like' process 2. present, but as an indistinct process, no longer being distinctly 'peg-like', as their lateral margin is contiguous with that of the osteoderm ventrolateral surface
443	**Presacral dorsal armour, surface of only the paravertebral osteoderms: (*)** *Andrade et al. (2011, ch. 476); Nesbitt (2011, ch. 404); Young et al. (2012, ch. 235); Young (2014, ch. 246); Young et al. (2016, ds 2, ch. 287); Ristevski et al. (2018, ds 2, ch. 367); Smith et al. (in review, ds 1, ch. 373); Ősi et al. (2018, ds 1, ch. 433).* *Crocodile-line archosaurs including, basal crocodylomorphs, have state (1).* *In Thalattosuchia* Teleosaurus cadomensis *and* Platysuchus multiscrobiculatus *also have state (1).* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. either weakly arched or mostly straight, forming a flat osteoderm, either keeled or not 1. osteoderm either strongly curved, with convex surface, partially embracing the vertebrae from side to side, or the curvature is restricted to a distinct bend near the lateral edge
444	**Presacral dorsal armour, biserial or tetraserial dorsal shield: (*)** *Young & Andrade (2009, ch. 147 part); Young et al. (2011, ch. 147 part); Young et al. (2013a, ch. 197 part); Young et al. (2012, ch. 232 part); Young (2014, ch. 243*

	part); Young et al. (2016, ds 2, ch. 289); Ristevski et al. (2018, ds 2, ch. 368); Smith et al. (in review, ds 1, ch. 374); Ősi et al. (2018, ds 1, ch. 434). *State (1) occurs in Susisuchidae + Eusuchia.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. biserial dorsal shield (one pair of paramedian osteoderms per row) 1. tetraserial dorsal shield (two pairs of paramedian osterderms per row)
445	**Presacral dorsal armour, presence of accessory osteoderm columns that do not have a peg-like articulation with the paramedian column, and which are smaller in size than the paramedian column(s): (*) (ORDERED)** *Ristevski et al. (2018, ds 2, ch. 369); Smith et al. (in review, ds 1, ch. 375); Ősi et al. (2018, ds 1, ch. 435).* *This character is an amalgam of Andrade et al. (2011, ch. 472 + 473) and Young et al. (2016, ds 2, ch. 290).* *Similar to the character in: Norell & Clark (1990, ch. 12 mod.); Brochu (1999, ch. 37 mod.); Ortega et al. (2000, ch. 107).* *This character does not consider the accessory osteoderms of dyrosaurids to be homologous (see character relating to the 'lateral process').* *This character does not consider the accessory osteoderms of notosuchians to be homologous, as their accessory osteoderms can retain the same size and shape as the paramedian column.* *State (1) occurs in Bernissaartidae, Susisuchidae, and Eusuchia.* *State (2) occurs in* Brachychampsa *and* Alligator mississippiensis. *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent (either has: two paravertebral medial columns, the gobiosuchid, or notosuchian. or dyrosaurid morphology) 1. present, a lateral accessory column on either of the paramedian columns 2. present, two lateral accessory columns on either of the paramedian columns
446	**Presacral dorsal armour, presence of accessory osteoderm column that has a peg-like articulation with the paramedian column (through a 'lateral process' derived from the anterolateral margin of the paramedian osteoderms): (*)** *Jouve et al. (2008, ch. 37 mod.); Hastings et al. (2010, ch. 82 mod.); Young et al. (2016, ds 2, ch. 291); Ristevski et al. (2018, ds 2, ch. 370); Smith et al. (in review, ds 1, ch. 376); Ősi et al. (2018, ds 1, ch. 436).* *State (1) occurs in dyrosaurids.* *This character was applied to test the homology of accessory osteoderms in dyrosaurids.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent (either has: two paravertebral medial columns, the gobiosuchid or notosuchian or the advanced neosuchian morphology) 1. present, a lateral accessory column on either side of the paramedian columns, with articulations
447	**Presacral dorsal armour, presence of accessory osteoderm columns, anteriorly two lateral accessory columns which increase to four accessory columns in the trunk region: (*)** *Ristevski et al. (2018, ds 1, ch. 477); Smith et al. (in review, ds 2, ch. 477); Ősi et al. (2018, ds 1, ch. 437).* *State (1) occurs in* Gobiosuchus*.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent (either has: two paravertebral medial columns, only two accessory columns, or the notosuchian morphology) 1. present
448	**Presacral dorsal armour, dimensions of the thoracic osteoderms: (*)** *Clark (1994, ch. 95 mod.); Nesbitt (2011, ch. 407); Young et al. (2012, ch. 234); Young (2014, ch. 245); Young et al. (2016, ds 2, ch. 292); Wilberg (2017, ch. 395 part); Ristevski et al. (2018, ds 2, ch. 371); Smith et al. (in review, ds 1, ch. 377); Ősi et al. (2018, ds 1, ch. 438).* *Crocodile-line archosaurs, including basal crocodylomorphs, have state (1).* *In Thalattosuchia, cervical osteoderms can be either state (0) or (1), so Young et al. (2016, ds 2) altered this character not to include the cervical osteoderms.* *Crocodyliformes have state (2).* *This character is not applicable for taxa that lack dorsal osteoderms.*

	0. square shaped, length and width approximately equal 1. longer than wide 2. wider than long
449	**Presacral dorsal armour, transverse elongation of the thoracic osteoderms: (*)** *Wilberg (2017, ch. 395 part); Ristevski et al. (2018, ds 2, ch. 372); Smith et al. (in review, ds 1, ch. 378); Ősi et al. (2018, ds 1, ch. 439).* *State (1) occurs in goniopholidids and pholidosaurids (reversal in dyrosaurids).* *This character can only be scored for those osteoderms that overlay the thoracic vertebrae, and come from the middle region of the trunk.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. transverse width of these osteoderms is either small or sub-equal to the anteroposterior length, or only slightly wider 1. considerably wider than long, such that the transverse width is approximately three times the anteroposterior length
450	**Presacral dorsal armour, type of contact between elements in a row: (*)** *Clark (1994, ch. 98); Andrade et al. (2011, ch. 474); Ristevski et al. (2018, ds 2, ch. 373); Smith et al. (in review, ds 1, ch. 379); Ősi et al. (2018, ds 1, ch. 440).* *State (1) occurs in crown-group Crocodylia.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. imbricated, any given anterior trunk osteoderm partially overlays its following element 1. sutured, osteoderms do not cover adjacent dermal elements, and are sutured if in contact
451	**Presacral dorsal armour, presence of an anteroposteriorly directed keel on the dorsal surface of paramedial elements: (*)** *Buscalioni et al. (1992, ch. 22); Clark (1994, ch. 101 rev., part); Brochu (1999, ch. 35); Andrade et al. (2011, ch. 478); Young et al. (2012, ch. 240 mod.); Young (2014, ch. 251 mod.); Young et al. (2016, ds 2, ch. 298 mod.); Ristevski et al. (2018, ds 2, ch. 378 mod.); Smith et al. (in review, ds 1, ch. 384); Ősi et al. (2018, ds 1, ch. 441).* *State (0) occurs in* Pelagosaurus typus. *In Thalattosuchia the cervical and anterior dorsal osteoderms can have reduced keels, which can make it look as though they are absent. However, in* Pelagosaurus typus*, the anterior dorsal osteoderms lack keels, while the mid dorsal osteoderms are very poorly keeled (hard to discern from the interpit laminae). In Thalattosuchia the sacral and anterior-mid caudal osteoderms have raised keels, which along with the ventral caudal osteoderms are the most readily identifiable.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent on approximately half to all of the paravertebral osteoderms, or if present in the anterior half of the presacral dorsal armour hard to discern from the interpit laminae 1. present along more than half, to all, of the paravertebral osteoderms
452	**Presacral ventral armour, presence of ventral collar scales: (*)** *Poe (1997); Brochu (1999, ch. 156); Andrade et al. (2011, ch. 479); Ristevski et al. (2018, ds 2, ch. 379); Smith et al. (in review, ds 1, ch. 385); Ősi et al. (2018, ds 1, ch. 442).* *This character is not applicable for taxa that lack osteoderms.* 0. absent, no shield enlarged relative to other ventral scales 1. present, forming a single row of enlarged scales 2. present, forming two parallel rows of enlarged scales
453	**Presacral ventral armour, presence of paired ossifications:** *Buscalioni et al. (1992, ch. 21); Brochu (1999, ch. 39); Andrade et al. (2011, ch. 480); Ristevski et al. (2018, ds 2, ch. 380); Smith et al. (in review, ds 1, ch. 386); Ősi et al. (2018, ds 1, ch. 443).* 0. single or absent 1. present, pairs sutured together
454	**Postsacral (= caudal) armour, distribution of dorsal tail osteoderms:** *Clark (1994, ch. 99 mod.); Young (2006, ch. 49 part); Wilkinson et al. (2008, ch. 78 part); Young & Andrade (2009, ch. 78 part); Young et al. (2011, ch. 78 part); Young et al. (2013a, ch. 200 part); Young et al. (2012, ch. 237 mod.); Young (2014, ch. 248 mod.); Young et al. (2016, ds 2, ch. 295 mod.); Ristevski et al. (2018, ds 2, ch.*

	375 mod.); Smith et al. (in review, ds 1, ch. 381 mod.); Ősi et al. (2018, ds 1, ch. 444). *Young et al. (2012) split the dorsal and ventral tail osteoderm character as* Pelagosaurus *and* Pietraroiasuchus *lack ventral tail osteoderms, but have dorsal tail osteoderms.* 0. present 1. absent
455	**Postsacral (= caudal) armour, distribution of ventral tail osteoderms:** *Young (2006, ch. 49 part); Wilkinson et al. (2008, ch. 78 part); Young & Andrade (2009, ch. 78 part); Young et al. (2011, ch. 78 part); Young et al. (2013a, ch. 200 part); Young et al. (2012, ch. 238); Young (2014, ch. 249); Young et al. (2016, ds 2, ch. 296); Ristevski et al. (2018, ds 2, ch. 376); Smith et al. (in review, ds 1, ch. 382); Ősi et al. (2018, ds 1, ch. 445).* *State (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae, and also occurs in* Pietraroiasuchus. 0. present 1. absent
456	**Postsacral (= caudal) armour, distribution when present: (*)** *Clark (1994, ch. 99 mod.); Young (2006, ch. 49 part); Wilkinson et al. (2008, ch. 78 part); Young & Andrade (2009, ch. 78 part); Andrade et al. (2011, ch. 481); Ristevski et al. (2018, ds 2, ch. 377); Smith et al. (in review, ds 1, ch. 383); Ősi et al. (2018, ds 1, ch. 446).* *This character is not applicable for taxa that lack caudal osteoderms.* 0. a pair of rows, covering the vertebral column 1. several rows, enclosing the tail surface
457	**Postsacral (= caudal) armour, presence of an anteroposteriorly directed keel on the dorsal surface of paramedial elements: (*)** *Clark (1994, ch. 101 rev., part); Andrade et al. (2011, ch. 482); Ristevski et al. (2018, ds 2, ch. 381); Smith et al. (in review, ds 1, ch. 387); Ősi et al. (2018, ds 1, ch. 447).* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent 1. present
458	**Appendicular armour, presence of osteoderms on the limbs (at least in part):** *Pol & Norell (2004b, ch. 190); Nesbitt (2011, ch. 405); Young et al. (2016, ds 2, ch. 288); Wilberg (2017, ch. 406); Ristevski et al. (2018, ds 2, ch. 382); Smith et al. (in review, ds 1, ch. 388); Ősi et al. (2018, ds 1, ch. 448).* *Crocodyliformes have state (1), but perhaps with reversals in some clades.* *Limb osteoderms are rarely preserved, but have been mentioned for some dyrosaurids and advanced neosuchians.* 0. absent 1. present

Dermal ossifications: gastralia (Ch. 457; 0.217% of characters)

#	Description
459	**Gastralia:** *Nesbitt (2011, ch. 412); Ristevski et al. (2018, ds 2, ch. 383); Smith et al. (in review, ds 1, ch. 389); Ősi et al. (2018, ds 1, ch. 449).* *State (0) occurs in Postosuchus, 'sphenosuchians', and* Protosuchus. *State (1) occurs in crocodyliforms more derived than* Protosuchus. *State (2) occurs in* Simosuchus. 0. forming extensive ventral basket with closely packed elements 1. well-separated 2. absent

Soft tissue (Ch. 458 – 462; 1.087% of characters)

[Herein soft tissue characters are only scorable for extant taxa]

#	Description

460	**Iris colour: (*)** *Brochu & Storrs (2012, ch. 182); Narváez et al. (2015, ch. 182); Ősi et al. (2018, ds 1, ch. 450).* *State (0) occurs in* Mecistops, Crocodylus, Caiman, Melanosuchus, Gavialis *and* Alligator mississippiensis. *State (1) occurs in* Osteolameus, Tomistoma, Paleosuchus *and* Alligator sinensis. *This character cannot be scored for fossil taxa.* *All data from Brochu & Storrs (2012) and Narváez et al. (2015).* 0. greenish/yellowish 1. brown
461	**Tongue, presence of keratinised surface: (*)** *Brochu (1999, ch. 159); Andrade et al. (2011, ch. 483); Ristevski et al. (2018, ds 2, ch. 384); Smith et al. (in review, ds 1, ch. 390); Ősi et al. (2018, ds 1, ch. 451).* *State (1) is a putative apomorphy of Alligatoridae/Alligatoroidea.* *This character cannot be scored for fossil taxa.* *Originally based on Taplin & Grigg (1989), apud Brochu (1999).* 0. absent 1. presence
462	**Functional lingual salt glands, presence: (*)** *based on Taplin (1985); Taplin & Grigg (1989); Brochu (2007); Andrade et al. (2011, ch. 484); Ristevski et al. (2018, ds 2, ch. 385); Smith et al. (in review, ds 1, ch. 391); Ősi et al. (2018, ds 1, ch. 452).* *State (0) is a putative apomorphy of Alligatoridae.* *This character cannot be scored for fossil taxa.* 0. absent 1. present
463	***M. caudofemoralis*, morphology: (*)** *Frey et al. (1989); Brochu (1999, ch. 160); Andrade et al. (2011, ch. 486); Brochu & Storrs (2012, ch. 37); Narváez et al. (2015, ch. 37); Ristevski et al. (2018, ds 2, ch. 387); Smith et al. (in review, ds 1, ch. 393); Ősi et al. (2018, ds 1, ch. 454).* *State (0) occurs in* Gavialis. *State (1) is known for all other extant crocodylians.* *This character cannot be scored for fossil taxa.* 0. with single head 1. with double head (*longus* and *brevis*)
464	**Skin colour, response to environmental colour conditions: (*) (NEW)** *State (0) occurs in Alligatoridae (i.e.* Caiman, Melanosuchus, Paleosuchus *and* Alligator*),* Mecistops *and* Osteolameus. *State (1) occurs in the genus* Crocodylus *(i.e.* C. rhombifer, C. moreletti, C. acutus, C. intermedius, C. niloticus, C. suchus, C. siamensis, C. palustris, C. porosus, C. mindorensis, C. novaeguineae, C. johnsoni*).* *State (2) occurs in* Gavialis *and* Tomistoma*.* *This character cannot be scored for fossil taxa.* *All data from Merchant et al. (2018).* 0. no, or very little, skin colouration change 1. dorsolateral skin surfaces change to a lighter colour in a light environment 2. dorsolateral skin surfaces change to a darker colour in a lighter environment

S3) Character and OTUs breakdowns of the merged, and parent, datasets

Table (S3.1). Character break-down from the iterations of the Hastings dataset, ultimately merged into the Hastings and Young (H+Y) matrix. Hastings *et al*. (2015) utilised two datasets: 1) Hastings *et al*. (2010, 2011); and 2) adapted from Jouve *et al*. (2006). Young *et al*. (2016) utilised two datasets: 1) first iteration of a merged dataset, an updated version of the matrix of Hastings *et al*. (2015) with characters used by Young; and 2) an updated version of Young (2014) matrix.

Type of characters	Hastings *et al*. (2010, 2011, 2015, ds 1-Hastings)	Hastings *et al*. (2015, ds 2-Jouve)	Young *et al*. (2016, ds 1-Hastings)
Skull geometry & dimensions	1	3	1
Craniomandibular ornamentation	2	3	2
Cranial rostrum	17	32	19
Skull roof	11	24	21
Orbit & temporal region	7	30	7
Palate & perichoanal structures	4	27	4
Occipital	5	9	5
Braincase, basicranium & suspensorium	8	28	14
Mandibular geometry	-	2	-
Mandible	9	22	9
Dental & alveolar	17	20	22
Vertebrae & ribs	-	6	5
Pectoral girdle & forelimbs	-	11	2
Pelvic girdle & hind limbs	-	7	1
Osteoderms	1	10	8
Total character number	**82**	**234**	**120**
Total dental+craniomandibular	**81**	**200**	**104**
Total post-cranial	**1**	**34**	**16**
Dental+craniomandibular osteology %	***98.8***	***85.47***	***86.667***
Post-cranial osteology%	***1.2***	***14.53***	***13.333***

Table (S3.2). Character break-down from the major different iterations of the Young dataset, ultimately merged into the Hastings and Young (H+Y) matrix. Young *et al*. (2016) utilised two datasets: 1) first iteration of a merged dataset, an updated version of the matrix of Hastings *et al*. (2015) with characters used by Young; and 2) an updated version of Young (2014) matrix. ***** note, the analysis for Young *et al*. (2013a) is actually a precursor to the Young *et al*. (2012) paper, which ended up being published first.

Type of characters	Young (2006)	Wilkinson *et al*. (2008)	Young (2009) / Young & Andrade (2009)	Young *et al*. (2011)	Young *et al*. (2013a) *	Young *et al*. (2012)	Young *et al*. (2013b) / Young (2014)	Young *et al*. (2016, ds2-Young)
Skull geometry & dimensions	1	1	1	1	1	3	3	5
Craniomandibular ornamentation	1	1	2	2	2	2	2	2
Craniomandibular pneumaticity	-	-	2	2	2	3	3	3
Rostral neurovascular foramina	-	-	-	-	-	-	-	1
Cranial rostrum	9	11	21	22	25	29	31	35
Skull roof	5	14	33	33	31	34	34	41
Orbit & temporal region	4	7	16	16	15	19	19	22
Palate & perichoanal structures	-	3	7	10	9	13	14	15
Occipital	-	3	6	7	8	8	8	9
Braincase, basicranium & suspensorium	-	2	10	10	13	14	15	17
Mandibular geometry	-	-	-	2	2	2	2	2
Mandible	6	9	16	18	18	22	22	26
Dental & alveolar	7	9	13	20	20	26	30	43
Vertebrae & ribs	6	6	15	17	18	22	23	24
Pectoral girdle & forelimbs	5	6	9	13	14	16	16	18
Pelvic girdle & hind limbs	7	7	11	11	16	18	20	21
Osteoderms	3	3	4	6	6	9	9	14
Total character number	**54**	**82**	**166**	**190**	**201**	**240**	**251**	**298**
Total dental+craniomandibular	**33**	**60**	**127**	**143**	**147**	**175**	**183**	**221**
Total post-cranial	**21**	**22**	**39**	**47**	**54**	**65**	**68**	**77**
Dental+craniomandibular osteology %	***61.111***	***73.171***	***76.506***	***75.263***	***73.134***	***72.917***	***72.908***	***74.161***
Post-cranial osteology%	***38.889***	***26.829***	***23.494***	***24.737***	***26.866***	***27.083***	***27.092***	***25.839***

Table (S3.3). Character break-down from the different iterations of the merged Hastings + Young (H+Y) matrix.

Type of characters	Ristevski *et al*. (2018)	Smith *et al*. (in review)	Ősi *et al*. (2018)	Sven *et al*. (in prep.)	Current
Skull geometry & dimensions	6	7	10	10	10
Craniomandibular ornamentation	4	4	6	6	6
Internal neuroanatomy & sensory systems	1	1	1	3	3
Craniomandibular pneumaticity	4	4	4	4	4
Rostral neurovascular foramina	2	2	6	6	6
Cranial rostrum	53	53	58	58	58
Skull roof	50	51	52	52	52
Orbit & temporal region	27	29	29	29	29
Palate & perichoanal structures	19	19	22	23	23
Occipital	13	13	15	15	15
Braincase, basicranium & suspensorium	26	26	26	26	26
Mandibular geometry	4	4	8	8	8
Mandible	28	29	32	32	32
Dental & alveolar	52	52	65	65	65
Vertebrae & ribs	26	26	31	33	35
Pectoral girdle & forelimbs	17	17	23	23	23
Pelvic girdle & hind limbs	28	29	37	37	37
Osteoderms	23	23	24	24	24
Gastralia	1	1	1	1	1
Soft tissue	3	3	4	5	5
Total character number	**387**	**393**	**454**	**460**	**464**
Total dental+craniomandibular	***289***	***294***	***334***	***337***	***339***
Total post-cranial	***95***	***96***	***116***	***118***	***120***
Total soft tissue	***3***	***3***	***4***	***5***	***5***

Dental+craniomandibular osteology %	***74.677***	***74.809***	***73.568***	***73.261***	***72.944***
Post-cranial osteology%	***24.548***	***24.427***	***25.551***	***25.652***	***25.974***
Soft tissue %	***0.775***	***0.763***	***0.881***	***1.087***	***1.082***

Table (S3.4) Break-down of the OTUs per clade from iterations of the Hastings dataset, ultimately merged into the Hastings and Young (H+Y) matrix. Hastings *et al*. (2015) utilised two datasets: 1) matrix of Hastings *et al*. (2010, 2011); and 2) adapted from Jouve *et al*. (2006). Young *et al*. (2016) utilised two datasets: 1) first iteration of a merged dataset, an updated version of the matrix of Hastings *et al*. (2015) with characters used by Young; and 2) an updated version of Young (2014) matrix. Note, the taxonomic break-down is based on the current topology, which for some OTUs will differ from the position they had in earlier less complete analyses.

Clades of OTUs	Hastings *et al*. (2010)	Hastings *et al*. (2011)	Hastings *et al*. (2015, ds 1-Hastings)	Hastings *et al*. (2015, ds 2-Jouve)	Young *et al*. (2016, ds 1-Hastings)
Non-crocodylomorph outgroup	-	-	-	-	1
'Sphenosuchia' s. l.	-	-	-	2	2
Basal crocodyliforms	-	-	-	7	1
Notosuchia s. l.	-	-	-	15	-
Teleosauroidea	-	-	-	1	1
Basal metriorhynchoids	-	-	-	1	1
Basal metriorhynchines	-	-	-	1	1
Indet. Neosuchia	-	-	-	1	-
Atoposauridae	-	-	-	1	-
Bernissartiidae	-	-	-	1	-
Paralligatoridae	-	-	-	2	-
Hylaeochampsidae	-	-	-	1	-
Crown-Crocodylia	-	-	-	3	2
Goniopholididae	-	-	-	4	2
Pholidosauridae	3	3	3	5	8
Basal to dyrosaurids	-	-	-	-	3
Dyrosauridae	13	14	15	4	15
Total number of OTUs	**16**	**17**	**18**	**49**	**37**
Total character number	**82**	**82**	**82**	**234**	**120**
OTU # / Characters #	***5.125 : 1***	***4.824 : 1***	***4.556 : 1***	***4.776 : 1***	***3.243 : 1***

Table (S3.5). Break-down of the OTUs per clade from the major different iterations of the Young dataset, ultimately merged into the Hastings and Young (H+Y) matrix. Young *et al*. (2016) utilised two datasets: 1) first iteration of a merged dataset, an updated version of the matrix of Hastings *et al*. (2015) with characters used by Young; and 2) an updated version of Young (2014) matrix. Note, the taxonomic break-down is based on the current topology, which for some OTUs will differ from the position they had in earlier less complete analyses. ***** note, the analysis for Young *et al*. (2013a) is actually a precursor to the Young *et al*. (2012) paper, which ended up being published first.

Clades of OTUs	Young (2006)	Wilkinson *et al*. (2008)	Young (2009) / Young & Andrade (2009)	Young *et al*. (2011)	Young *et al*. (2013a) *	Young *et al*. (2012)	Young *et al*. (2013) / Young (2014)	Young *et al*. (2016, ds2-Young)
Non-crocodylomorph outgroup	-	-	1	1	1	1	1	1
'Sphenosuchia' s. l.	-	2	3	1	1	3	3	4
Basal crocodyliforms	1	1	1	1	1	1	1	1
Notosuchia s. l.	-	-	11	-	-	11	11	12
Atoposauridae	1	1	2	-	-	2	2	2
Goniopholididae	1	1	5	3	3	4	4	5
Susisuchidae	-	-	2	1	1	2	2	2
Hylaeochampsidae	-	-	-	-	-	-	-	2
Crown-Crocodylia	-	2	4	3	3	3	3	4
Pholidosauridae	-	-	6	1	1	1	1	7
Basal to dyrosaurids	-	-	-	-	-	-	-	3
Dyrosauridae	-	-	7	-	-	-	-	8
Teleosauroidea	1	1	4	1	1	9	9	12
Basal metriorhynchoids	2	2	6	6	6	6	6	6
Basal metriorhynchines	4	5	6	5	5	5	5	3
Rhacheosaurini	4	5	12	11	11	11	11	13
Basal geosaurines	3	3	5	5	5	5	5	5
Geosaurini	4	5	11	11	12	9	11	14
Total number of OTUs	**21**	**28**	**86**	**50**	**51**	**73**	**75**	**104**
Total character number	**54**	**82**	**166**	**190**	**201**	**240**	**251**	**298**

OTU # / Characters #	***2.571 : 1***	***2.929 : 1***	***1.930 : 1***	***3.800 : 1***	***3.941 : 1***	***3.288 : 1***	***3.467 : 1***	***2.865 : 1***

Table (S3.6). Break-down of the OTUs per clade from the different iterations of the merged Hastings + Young (H+Y) matrix. Note, the taxonomic break-down is based on the current topology, which for some OTUs will differ from the position they had in earlier less complete analyses.

Clades of OTUs	Ristevski *et al*. (2018)	Smith *et al*. (in review)	Ősi *et al*. (2018)	Sven *et al*. (in prep.)	Current
Non-crocodylomorph outgroup	1	1	1	1	1
'Sphenosuchia' s. l.	5	5	5	5	5
Basal crocodyliforms	5	5	5	5	5
Notosuchia s. l.	12	12	12	12	12
Atoposauridae	2	2	2	2	2
Goniopholididae	8	6	7	7	7
Bernissartiidae	2	2	2	2	2
Susisuchidae	2	2	2	2	2
Hylaeochampsidae	2	2	2	2	2
Crown-Crocodylia	4	4	4	4	4
Pholidosauridae	10	11	11	11	11
Basal to dyrosaurids	1	2	2	2	2
Dyrosauridae	16	17	17	17	17
Teleosauroidea	18	18	18	18	18
Basal metriorhynchoids	7	7	8	8	8
Basal metriorhynchines	4	4	4	4	4
Rhacheosaurini	14	14	14	15	16
Basal geosaurines	5	5	5	5	5
Geosaurini	19	19	19	19	19
Total number of OTUs	**137**	**138**	**140**	**141**	**142**
Total character number	**387**	**393**	**454**	**460**	**462**
OTU # / Characters #	***2.825 : 1***	***2.848 : 1***	***3.243 : 1***	***3.262 : 1***	***3.254***

S4) Supplementary references

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S5) List of institutional abbreviations

AMNH, American Museum of Natural History, New York City, NY, USA
BPI, Bernard Price Institute, Johannesburg, South Africa
BRLSI, Bath Royal Literary and Scientific Institute, Bath, England, UK
BRSMG, Bristol City Museum & Art Gallery, Bristol, England, UK
BSPG, Bayerische Staatssammlung für Paläontologie und Historische Geologie, München, Germany
CAMSM, Sedgwick Museum of Earth Science, University of Cambridge, England, UK
CM, Carnegie Museum of Natural History, Pittsburgh, PA, USA
CMC, Cincinnati Museum Center, Cincinnati, OH, USA
DORCM, Dorchester County Museum, Dorchester, United Kingdom

DGM, Departamento Nacional de Produção Mineral, Rio de Janeiro, Brazil
FEF, Fundação Educacional de Fernandópolis, Fernandópolis, Brazil
FMNH, Field Museum of Natural History, Chicago, Illinois, USA
GLAHM, Hunterian Museum, Glasgow, Scotland, UK
IGM, Mongolian Institute of Geology, Ulaan Bataar, Mongolia
IRSNB, Institut Royal des Sciences Naturelles de Bruxelles, Belgium
IVPP, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China
IWCMS, Isle of Wight County Museums Services (Dinosaur Isle Museum and visitor attraction) Sandown, UK
LACM, Natural History Museum of Los Angeles County, Los Angeles, California, USA
MACN, Museo Argentino de Ciências Naturales 'Bernardino Rivadavia', Buenos Aires, Argentina
MANCH, Manchester Museum, Manchester, United Kingdom
MB, Museum für Naturkunde der Humboldt Universität, Berlin, Germany
MCZ, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA
ME, Musée d'Elbeuf, Elbeuf, Normandie, France
MHNG, Muséum d'histoire Naturelle de la Ville de Genève, Switzerland
MHNSR, Museo de Historia Natural de San Rafael, San Rafael, Argentina
MJML, Museum of Jurassic Marine Life, Kimmeridge, Dorset, England, UK
MLP, Museo de La Plata, La Plata, Argentina
MNHN.F, fossil collection of the Muséum national d'Histoire naturelle, Paris, France (ALG, Algiers locality; CNJ, Canjeurs locality; GDF, Gadoufaoua (Tegema Beds); INA, In Abangharit locality; MRS, Maroc Sud, i.e. Kem Kem localities; SAM, Gara Samani locality)
MN-UFRJ, Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil
MOZ, Museo Profesor J. Olsacher, Zapala, Argentina
MPCA, Museo Provincial "Carlos Ameghino", Cipolletti, Rio Negro, Argentina
MPEF, Museo Paleontologico Egidio Feruglio, Trelew, Argentina
MPMA, Museu de Paleontologia de Monte Alto, Monte Alto, Brazil
MTM, Magyar Természettudományi Múzeum, Budapest, Hungary
MUCPv, Museo de la Universidad Nacional del Comahue, Neuquén, Argentina
NHMUK PV, vertebrate palaeontology collection of the Natural History Museum, London, England, UK (OR, old register; R, reptiles)
NJSM, New Jersey State Museum, Trenton, New Jersey, USA
OMN, Musée de l'Office National Des Mines, Tunis, Tunisia
OUMNH, Oxford University Museum of Natural History, Oxford, England, UK
PETMG, Peterborough Museum & Art Gallery, Peterborough, England, UK
PVL, Instituto Miguel Lillo, Tucuman, Argentina
RCL, Museu de Ciências Naturais da Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Brazil
RMS, Royal Museum Scotland, Edinburgh, Scotland, UK
SAM, Iziko-South African Museum, Cape Town, South Africa
SMNK, Staatliches Museum für Naturkunde Karlsruhe, Germany
SMNS, Staatliches Museum für Naturkunde Stuttgart, Germany
UA, University of Antananarivo, Madagascar
UCMP, University of California Museum of Paleontology, Berkeley, California, USA

UF/IGM, University of Florida, Florida Museum of Natural History, Gainesville, Florida, USA / Museo Geológico, at the Instituto Nacional de Investigaciones en Geociencias, Minería y Quimica, Bogotá, Colombia
UFRJ-DG, Departamento de Geologia, Universidade Federal do Rio de Janeiro, Brazil
URC, IGCE-UNESP, Museu “Paulo Milton Barbosa Landim”, Instituto de Geociências e Ciências Exatas, Universidade Estadual Paulista, Rio Claro, Brazil
USNM, National Museum of Natural History, Washington DC, USA
YPM, Peabody Museum of Natural History, Yale University, New Haven, Connecticut, USA
ZPAL, Instytut Paleobiologii PAN, Warszawa, Poland

APPENDIX S1.2

TAXON SUPPLEMENTARY MATRIX FOR:

Re-description of two contemporaneous mesorostrine teleosauroids (Crocodylomorpha, Thalattosuchia) from the Bathonian of England, and insights into the early evolution of Machimosaurini

by Michela M. Johnson[1], Mark T. Young[1], Stephen L. Brusatte[1,2]

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[2]National Museum of Scotland, Chambers Street, Edinburgh, EH1 1JF, UK

Corresponding supplementary character matrix provided in Johnson et al. (2019), of 143 taxa and 464 characters. Character 1 begins from the left-most side, and subsequent characters proceed as follows.

xread
464 143
Postosuchus_kirkpatricki 0 ? ? 0 ? 0 2 ?
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0 0 0 ? 1 0 0 0 2 0 0
? 0 0 3 0 ? 0 0 ? 2 0
0 0 1 1 ? 0 1 - 0 0 1
0 0 0 0 0 0 0 0 ? 0 0
0 1 0 1 1 0 2 3 0 1 0
0 0 0 0 0 0 0 1 2 1 0
0 0 0 1 - 0 1 - 0 0 0
- 1 1 0 0 1 0 1 0 0 0

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2	0	0	0	1	0	0	0	0	0	-
-	1	0	0	0	0	3	0	0	?	0
?	?	0	0	0	0	?	?	?	?	1
0	-	?	?	?	?	0	0	0	?	0
0	0	2	-	0	?	0	?	0	0	0
0	1	?	?	?	?	?	0	0	0	?
?	?	0	?	?	0	0	0	?	0	?
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0	0	0	?	?	0	0	?	0	0	0
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?	?	?	?	?	?	0	0	0	0	0
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0	2	1	1	?	?	0	0	0	?	?
2	?	?	0	?	?	?	0	0	0	0
0	0	?	?	?	?	?	2	?	0	?
0	0	0	[12]	0	0	0	0	?	0	0
0	0	0	0	0	1	1	0	?	?	?
3	?	?	0	0	?	?	?	0	0	0
0	?	?	?	?	?	0	?	?	?	?
0	?	?	?	?	?	0	?	?	?	?
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?	?	?	?	0	?	?	2	?	?	1
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?	1	2	3	1	0	0	1	1	1	?
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-	-	-	-	-						
Dromicosuchus_grallator			?	?	?	0	?	0	2	0
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0	-	0	3	0	0	0	0	?	2	3
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?	?	0	?	2	?	?	?	?	?	?
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Hesperosuchus_cf_agilis ? ? ? 0 ? 0 2 0
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?	?	?	?	?	?	2	0	0	0	0
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Eopneumatosuchus_colberti			1	?	?	?	?	?	?	?
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1	0	1	2	0	0	0	1	0	2	?

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?	?	?	?	?	?	?	?	?	?	?
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?	1	3	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
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Hemiprotosuchus_leali		0	0	0	0	?	0	2	0	0
0	?	?	0	2	?	1	?	?	?	1
0	?	?	0	?	?	0	?	0	0	0
0	?	?	1	0	0	0	2	0	?	?
0	0	?	1	?	0	0	1	2	1	0
0	?	1	?	?	0	0	1	?	0	?
?	?	?	?	?	?	?	?	?	?	0
1	0	1	0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	1	0	0	0
0	1	0	0	0	?	0	0	?	0	-
0	0	?	?	?	0	1	?	0	?	1
?	?	0	0	0	0	0	0	?	?	1
?	1	0	0	0	0	?	?	?	2	0
0	0	0	?	1	0	0	0	0	-	-
?	?	0	0	0	2	?	1	?	0	?
0	0	1	1	?	?	?	?	?	?	?
?	?	?	?	?	?	?	0	?	?	?
?	?	-	0	0	?	?	1	?	0	?
?	?	0	0	?	1	0	1	?	?	?
?	?	?	?	0	?	?	?	?	?	?
?	?	?	?	?	?	0	?	?	0	?
0	0	?	0	0	0	0	0	0	0	?

0 0 ? ? ? 2 [01] 0 2 ? ?
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1 0 0 1 0 ? ? ? ? 0 ?
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Protosuchus_richardsoni 0 0 0 0 ? 0 2 0
0 1 1 0 0 2 1 1 ? ? 0
1 ? ? 2 0 1 1 0 0 0 0
0 0 0 ? 1 0 0 0 2 0 0
? 0 0 0 1 ? 0 0 1 2 1
0 0 1 1 0 0 0 0 1 0 0
0 0 0 0 0 0 ? 0 ? 0 0
0 ? ? ? ? ? ? ? 0 ? 0
0 ? 1 1 0 0 0 0 1 0 0
0 0 2 0 0 0 2 0 0 0 0
- 0 0 0 0 0 0 1 0 1 0
1 2 0 0 0 0 0 0 0 0 1
1 0 1 0 0 0 0 1 0 2 2
0 0 0 0 0 1 0 0 0 0 -
- 2 0 0 0 0 2 0 1 1 0
0 0 0 1 1 0 ? ? [12] ? 2
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0 0 0 ? 0 0 0 0 0 0 0
1 0 0 0 ? ? 2 5 0 2 0
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1 ? 0 ? ? 0 0 - - - 0
0 2 1 ? ? ? ? 0 0 ? ?
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? 1 0 0 1 0 [01] [01] ? ? 0
? 0 0 0 ? ? ? ? ? ? ?
0 - ? 0 0 ? ? ? 0 0 0

?	0	0	0	0	0	0	0	?	?	?
0	0	0	?	?	?	0	?	0	0	0
0	-	0	0	0	0	-	0	0	?	0
0	0	?	0	2	0	0	1	1	0	1
1	0	0	0	0	0	0	0	?	?	?
0	0	0	?	0	0	0	1	1	0	0
?	0	0	0	0	0	?	?	?	1	0
0	1	1	1	1	0	0	1	1	1	0
1	1	0	0	0	0	2	2	?	?	1
1	0	2	0	1	1	0	0	0	0	2
0	0	1	?	?	0	0	1	1	1	0
-	-	-	-	-						
Protosuchus_haughtoni	0	0	0	0	?	0	2	0	0	
1	1	0	0	2	1	1	?	?	?	?
0	?	2	0	1	1	0	0	0	0	0
0	0	?	1	0	0	0	2	0	0	?
0	0	0	1	?	0	0	1	2	1	0
0	1	1	?	0	0	0	1	0	0	0
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0	2	0	0	0	2	0	0	0	0	-
0	0	0	0	0	0	1	0	1	0	1
2	0	0	0	0	0	0	0	0	1	1
0	1	0	0	0	0	1	0	2	2	0
0	0	0	0	1	0	0	0	0	-	-
2	0	0	0	0	2	0	1	1	0	0
0	0	?	0	0	?	?	[12]	?	2	0
-	?	?	?	?	?	?	0	0	0	?
?	1	-	?	?	?	0	1	1	0	1
?	0	0	0	0	1	0	1	0	0	?
?	0	?	?	0	0	0	0	1	0	0
?	?	0	0	1	1	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	2	?	0	2	0	?
1	0	0	0	0	1	0	0	0	1	1
0	0	?	?	0	0	-	-	-	?	0
2	1	?	?	?	0	0	0	?	?	?
?	?	0	?	?	?	?	?	?	?	?
?	?	?	?	?	0	2	0	0	?	0
1	?	0	1	0	[01]	?	0	0	0	0
0	0	0	0	1	1	0	?	?	?	?
?	?	0	0	?	?	?	0	0	0	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?

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Fruitachampsa_callisoni	1	0	?	?	?	0	0	0	0	
0	1	0	0	2	1	?	?	?	?	?
0	?	?	0	?	?	0	?	0	0	0
0	?	?	1	0	0	0	2	?	?	?
?	?	?	?	?	0	0	?	2	1	0
0	1	1	0	0	0	0	1	?	?	?
0	0	0	0	?	?	1	0	0	0	0
0	0	-	-	-	0	0	-	-	-	-
0	1	1	?	?	0	0	0	0	0	0
0	1	0	0	0	?	0	0	?	0	-
0	0	?	?	?	0	1	?	0	0	1
2	0	?	0	0	0	0	0	?	?	1
?	1	0	0	0	?	?	?	?	1	0
0	0	?	?	?	0	0	0	0	-	-
2	0	0	0	0	3	0	1	1	?	?
0	0	1	2	?	1	?	2	0	2	1
0	0	?	?	?	?	?	2	0	?	0
0	?	1	?	0	0	?	1	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	1	1	0	?	?	0	?
1	3	?	0	0	0	0	0	0	0	1
0	0	0	?	?	?	?	?	?	0	?
?	?	?	?	?	0	?	0	0	?	?
?	?	?	?	0	?	?	?	?	?	0
?	0	?	?	?	?	?	0	?	?	?
0	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	0	?	?	?
?	?	0	?	0	1	?	0	0	0	0
0	0	0	0	?	0	-	?	-	-	0
-	0	0	?	?	?	?	?	?	0	0
?	?	?	?	?	3	?	?	?	?	3
?	?	?	?	?	?	?	2	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	0	?	0	0	0	?	?	?	?
?	0	0	?	?	?	?	?	?	?	?
0	0	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	1	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	-
-	-	-	-							
Mariliasuchus_amarali	1	4	0	0	?	0	2	?	0	
0	2	0	0	?	0	0	?	?	0	?
0	?	2	0	1	1	0	0	0	0	0
5	?	?	0	0	0	?	0	?	?	?
?	?	0	1	?	0	1	1	0	1	0
0	1	0	?	0	1	0	1	0	0	?

0 0 0 ? ? ? ? 0 0 0 0
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0 1 1 1 0 0 0 0 3 0 0
0 2 0 0 0 1 0 0 0 0 -
? 0 0 ? 0 ? ? ? 0 0 0
2 0 0 0 0 0 0 0 ? ? 1
0 1 1 0 0 ? ? ? ? 2 0
0 0 1 1 0 0 0 0 0 - -
2 0 0 0 ? ? 0 1 0 0 ?
? 0 ? 1 ? 0 - 2 0 2 1
0 ? ? 1 - 0 0 2 ? ? 1
0 ? 1 1 ? 1 ? 1 1 0 ?
? ? ? ? ? 0 1 1 ? 0 ?
? ? 0 ? 1 0 0 0 1 0 0
0 ? ? ? ? ? ? ? ? ? ?
1 ? ? 0 0 0 1 1 0 0 2
? ? 0 0 0 2 0 0 2 0 ?
0 - - - ? 0 ? 0 0 1 0
1 0 ? 1 1 ? 2 ? ? ? 0
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0 0 2 1 0 2 0 0 0 0 0
0 0 0 0 1 1 0 ? 0 2 1
0 2 0 0 ? ? ? 1 0 0 ?
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1 1 0 1 0 0 ? ? ? ? ?
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Notosuchus_terrestris 1 4 0 0 ? 0 2 ? 0
0 2 0 0 2 0 0 ? ? 0 1
0 ? 2 0 1 1 0 0 0 0 0
5 ? 0 0 0 0 ? 0 ? ? ?
? ? 0 1 ? 0 1 1 0 1 0
0 1 0 ? 0 1 0 1 0 0 0
0 0 0 0 ? 1 ? 1 0 0 0
1 0 0 0 0 0 1 0 0 0 0
0 1 1 1 0 0 0 0 0 0 0
0 2 0 0 0 1 0 0 0 0 -
0 0 ? 0 0 ? ? ? 0 0 0
0 0 0 0 0 0 0 0 ? 1 1
0 1 1 ? 0 ? ? ? ? 2 0
0 0 0 0 ? ? ? ? ? - -
2 ? 0 0 ? ? 0 1 0 0 ?

1	0	1	1	0	1	0	2	0	2	1
0	0	?	1	-	0	0	2	?	0	1
0	?	1	1	?	1	?	1	1	0	1
?	1	?	?	0	0	1	1	?	0	?
?	?	0	0	1	0	0	0	1	0	0
0	?	?	1	1	1	?	?	?	?	1
1	?	0	0	0	0	1	1	0	0	2
?	?	0	0	0	2	1	0	2	0	?
0	-	-	-	0	0	?	0	0	1	0
1	0	0	1	1	0	2	?	?	0	0
2	0	?	?	?	?	0	1	?	?	3
?	?	0	?	?	?	0	?	?	?	?
?	?	?	?	?	0	?	?	0	0	?
0	0	2	?	0	2	0	0	0	0	0
0	1	0	0	1	1	0	?	0	2	1
0	2	1	?	?	?	?	1	0	0	?
?	1	?	0	?	0	?	?	?	?	0
?	?	?	?	?	1	?	0	0	?	0
?	?	?	?	?	?	?	0	?	?	?
?	?	0	?	?	0	1	1	1	1	?
0	0	0	0	?	0	0	?	?	?	1
0	0	?	1	1	0	2	?	?	1	?
?	?	?	?	?	?	?	?	?	?	0
1	1	0	1	0	0	?	?	1	1	1
1	?	?	?	?	?	?	0	-	1	?
?	?	0	?	0	0	0	0	0	?	?
?	?	?	?	?	?	?	?	?	?	-
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Adamantinasuchus_navae			0	?	?	?	?	0	2	?
0	0	2	0	0	?	?	?	?	?	?
?	0	?	?	0	1	1	0	0	0	0
0	5	?	?	1	0	0	?	0	?	?
?	0	0	0	1	?	0	1	1	0	1
0	0	1	0	?	0	?	0	?	0	0
?	0	0	0	?	?	?	1	1	0	0
0	0	0	-	-	-	0	0	-	-	-
-	0	1	1	?	0	0	0	0	?	?
?	0	2	?	0	0	1	0	0	0	0
-	?	?	0	?	?	?	?	?	0	0
0	?	0	0	0	0	0	0	0	?	?
1	0	?	?	?	0	?	?	?	?	2
0	0	0	1	1	0	0	0	0	0	-
-	?	0	0	0	0	3	0	1	0	?
?	?	0	?	?	?	?	?	?	0	?
?	?	?	?	?	?	?	0	2	?	?
?	?	?	1	?	?	?	?	1	?	?
?	?	?	?	?	?	?	1	1	?	?
?	?	?	?	?	?	?	?	?	1	?
0	0	?	?	?	?	?	?	?	?	?
?	1	?	?	0	0	0	1	1	[01]	0
2	?	?	?	?	?	2	0	0	2	?
?	?	?	0	?	?	0	0	0	0	1

?	1	0	?	?	?	?	?	?	?	?
0	3	0	?	?	?	-	0	0	?	?
3	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	?	1	0	0
?	0	0	2	?	0	2	?	0	0	0
0	?	0	0	0	1	1	0	?	0	2
1	0	2	0	0	?	?	?	2	1	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	?	?	?	?	?	?	?	?	?	?
0	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	0	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	1	1	?	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	0	-	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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Sphagesaurus_huenei		0	[04]	0	0	?	0	2	?	0
0	2	0	0	?	0	?	?	?	?	?
?	?	2	0	1	1	0	0	?	0	0
5	?	?	1	0	0	?	0	?	?	?
0	0	0	1	?	0	1	1	0	1	0
0	1	0	?	0	1	0	1	0	0	0
0	0	0	0	?	?	0	1	0	0	0
0	0	-	-	-	0	0	-	-	-	-
0	1	0	0	?	0	0	0	0	0	0
0	2	0	0	0	1	0	0	0	0	-
?	?	?	?	0	0	?	?	?	?	?
?	?	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	2	0
0	0	1	1	0	0	0	0	0	-	-
?	?	0	0	0	3	0	1	0	?	?
1	0	1	1	0	0	-	2	0	2	1
0	?	4	1	-	0	0	2	?	?	1
?	?	1	1	?	?	?	?	1	?	?
?	?	?	?	?	?	1	1	?	?	?
?	?	?	?	1	0	0	?	1	?	?
?	?	?	?	?	?	?	?	?	?	?
1	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
3	0	?	?	?	-	0	0	?	?	3
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	?	1	?	0	?
0	0	2	0	0	2	2	0	0	0	0
1	1	0	0	1	1	0	?	0	2	1
0	2	1	1	?	?	?	2	1	0	?
?	?	?	?	?	?	?	?	?	?	?
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Caipirasuchus_montealtensis 0 [04] 0 0 ? 0 2 ?
0 0 2 0 0 ? 1 0 ? ? ?
? 0 1 2 0 1 1 0 0 0 0
0 5 ? ? 1 0 0 ? 0 ? ?
? 0 0 0 1 ? 0 1 1 0 1
0 0 1 0 0 0 1 0 1 0 0
0 0 0 0 0 0 1 0 1 0 0
0 1 0 0 0 0 0 0 0 0 0
0 0 1 0 0 ? 0 0 0 0 0
0 0 2 0 0 0 1 0 0 0 0
- 0 0 0 0 0 0 1 0 0 0
0 0 0 0 0 0 0 0 0 ? ?
? ? 1 1 0 0 0 1 ? 2 2
0 0 0 1 1 0 0 0 0 0 -
- 2 0 0 0 0 3 0 1 0 0
? 1 0 1 0 0 0 - 2 0 2
1 0 0 4 1 - 0 0 2 ? 0
1 0 ? 1 1 ? 1 ? 1 1 0
1 1 ? ? ? ? ? 1 1 0 0
? 0 ? ? ? 1 ? ? ? 1 ?
? ? ? 0 ? ? ? ? ? ? 0
? 1 ? ? 0 0 0 1 1 ? 0
2 ? 0 0 ? ? 2 0 0 2 0
? 0 - - - 0 0 0 0 0 1
? 1 0 ? ? ? ? ? ? ? ?
0 ? 0 1 ? ? ? 0 0 ? ?
3 ? ? 0 ? ? ? 0 ? 0 ?
? ? 0 ? ? ? 0 ? 1 0 0
? 0 0 2 0 0 2 2 0 0 0
0 ? 1 0 0 1 1 0 ? 0 2
1 0 2 1 1 ? ? 0 2 1 0
0 ? ? ? ? 0 ? ? ? ? ?
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? ? 0 0 0 0 ? ? ? ? ?
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? ? 0 ? ? ? ? ? 0 - 1
? ? ? ? ? ? 0 0 0 0 ?

?	0	1	?	?	?	?	?	?	?	?
-	-	-	-	-						
Baurusuchus_pachecoi	0	4	0	0	?	0	2	0	0	
0	2	0	0	?	1	0	?	?	?	1
?	?	2	0	1	1	0	0	0	0	0
5	0	0	0	0	0	0	2	0	0	?
0	0	0	1	?	0	0	2	2	1	0
0	1	0	?	0	1	0	1	0	1	0
0	0	0	0	?	?	0	1	0	0	0
0	0	-	-	-	0	0	-	-	-	-
0	1	1	1	0	0	0	0	4	0	0
0	1	1	0	0	1	0	0	0	0	-
0	1	0	?	0	?	?	?	?	0	0
?	0	0	0	0	0	0	0	?	0	1
0	1	2	0	0	0	1	?	2	2	0
0	0	0	0	0	0	0	0	0	-	-
2	0	1	0	?	3	0	1	0	0	?
?	0	1	1	0	0	-	2	0	2	1
0	?	?	1	-	0	0	2	?	?	1
0	?	1	1	?	1	?	1	1	0	1
0	?	?	?	?	?	1	1	?	0	?
?	?	0	?	1	0	0	0	1	0	0
0	?	?	?	1	1	1	?	?	0	1
1	3	?	0	0	0	0	0	0	0	2
?	?	2	1	0	2	0	0	2	1	?
0	-	-	-	1	0	?	0	0	0	1
1	0	?	?	1	0	2	1	0	0	0
2	0	2	?	?	?	0	0	?	?	3
?	?	0	?	?	?	0	1	?	0	1
?	0	?	?	?	1	1	0	0	0	?
1	1	0	1	0	0	0	0	0	0	0
0	0	0	0	0	1	0	?	?	2	3
0	2	0	0	?	?	?	0	0	0	?
?	?	0	?	?	?	?	?	?	?	?
?	?	?	?	?	1	?	?	?	?	0
?	0	0	0	0	?	?	?	?	?	0
0	?	?	?	?	?	?	?	?	1	0
?	?	?	?	0	?	?	?	?	?	?
?	?	?	1	1	?	?	1	?	?	?
0	?	?	0	?	?	?	?	1	0	?
1	1	0	1	0	0	?	?	?	?	?
?	?	?	?	?	?	?	0	-	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	-
-	-	-	-							
Araripesuchus_patagonicus		1	0	0	0	?	0	2	0	
0	0	1	0	0	2	0	0	?	?	?
?	1	?	2	0	?	?	?	0	0	?
0	?	?	?	?	0	0	?	1	?	?
?	?	?	?	?	?	?	0	0	?	1
?	?	?	1	?	0	0	0	1	0	0
?	0	0	0	0	?	0	0	2	0	0

0	1	0	0	0	0	0	1	0	0	0
0	0	1	1	1	0	0	0	0	0	0
0	0	2	0	0	0	0	0	0	?	0
-	0	0	0	0	0	?	1	0	0	0
0	2	0	0	0	0	0	0	0	?	1
1	0	1	0	0	0	0	?	?	?	2
0	0	0	0	0	0	0	0	0	0	-
-	2	0	0	0	0	0	0	1	0	?
?	1	0	1	2	0	?	?	2	0	2
1	0	?	?	0	1	0	0	2	?	0
1	1	?	1	1	?	2	?	1	1	?
1	1	?	?	?	?	?	1	1	?	0
?	?	1	0	0	1	0	0	0	1	0
0	0	?	?	?	1	1	1	1	0	?
1	1	3	?	0	0	0	0	0	1	0
1	?	?	?	?	?	2	3	1	2	?
?	?	?	0	?	0	0	0	0	0	?
0	?	0	?	?	1	0	1	0	0	0
0	2	1	?	?	?	0	?	0	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
?	?	0	[12]	?	0	1	?	0	0	0
0	0	0	0	0	1	?	?	?	?	?
?	?	?	?	?	?	?	?	0	?	0
?	?	?	0	?	?	0	0	?	?	?
0	?	?	?	?	?	?	?	?	?	?
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	1	?	0	1
0	0	0	0	0	?	0	0	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	1	1	1	1	1	0	?	?	?	?
?	?	?	?	?	?	?	?	1	1	1
0	0	2	0	?	?	0	0	0	0	2
0	0	1	-	0	?	?	?	?	?	?
-	-	-	-	-						
Montealtosuchus_arrudacamposi				0	0	0	0	?	0	2
0	0	0	1	0	0	2	0	0	?	?
?	?	1	?	2	?	1	0	0	0	0
0	0	5	0	0	1	0	0	0	2	0
0	0	0	0	0	1	?	0	0	2	2
1	0	0	1	1	?	0	0	0	?	?
2	0	0	0	0	0	?	0	2	-	0
0	0	1	0	0	0	0	0	1	0	1
0	0	0	1	1	1	0	0	0	0	0
0	0	0	2	0	0	0	0	0	0	0
0	-	0	0	0	0	0	0	1	1	0
?	0	0	0	0	0	0	0	0	0	?
1	1	1	1	0	0	0	0	?	?	?
2	0	0	0	0	0	0	0	0	0	0
-	-	2	0	1	0	0	3	0	1	0
?	?	?	0	1	1	?	1	0	2	0

2 1 0 0 ? 0 1 0 0 2 ?
0 1 1 ? 1 1 ? 2 ? 1 1
0 1 ? 0 ? ? ? 0 1 1 0
0 ? ? ? 0 ? 1 0 0 0 1
0 0 0 ? 0 ? ? ? 1 ? ?
0 1 1 3 ? 0 0 0 0 0 1
0 2 0 0 2 0 0 2 3 1 2
1 ? ? ? 0 ? 1 1 0 1 1
0 0 1 0 ? 1 1 1 1 0 0
0 0 1 1 1 ? ? 0 0 0 ?
? 2 ? ? 0 0 ? ? 0 0 ?
0 0 ? 0 0 ? ? ? 1 0 0
0 ? 1 1 0 1 0 0 0 0 0
0 0 0 0 0 0 0 1 0 ? ?
2 3 0 2 0 0 ? ? ? 0 0
0 ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
1 ? ? ? ? ? ? ? ? ? ?
? 1 ? 0 ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? 1 1 ? ? ? ? ? ? ?
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? ? ? ? ? ? ? ? ? ? ?
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Uberabasuchus_terrificus 0 4 0 0 ? 0 2 0
0 0 1 0 0 ? 0 0 ? ? ?
? ? ? ? 0 1 0 0 0 0 0
0 5 0 0 1 0 0 0 2 0 0
? 0 0 0 1 ? 0 0 2 2 1
0 0 1 1 ? 0 0 0 ? 1 2
0 0 0 0 ? ? 0 2 - 0 0
0 1 0 0 0 0 0 0 0 1 0
0 0 1 1 1 0 0 0 0 4 0
0 0 2 0 0 0 0 0 0 0 0
- 0 0 0 ? 0 0 1 1 ? ?
0 1 0 0 0 0 0 0 0 ? ?
1 1 1 0 0 0 0 ? ? ? 2
0 0 0 0 0 0 0 0 0 0 -
- 2 0 1 0 0 3 ? 1 0 ?
? ? 0 ? 1 0 ? ? 2 0 ?
? 0 ? ? ? ? ? 0 2 ? ?
? ? ? ? ? ? 2 ? 1 1 0
1 0 ? ? ? ? ? ? ? ? 0
? ? ? 0 ? [12] 0 0 0 ? 0
0 0 ? ? ? ? ? ? ? ? ?
1 ? ? ? 0 0 0 0 0 2 1
2 0 0 2 0 0 2 3 1 2 1
? ? ? 0 ? 1 1 0 1 ? ?
0 1 0 ? ? 1 1 1 0 0 0

0	1	1	?	?	?	0	0	0	?	?
2	?	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	1	1	0	0	0
?	1	1	0	1	0	1	1	0	0	0
0	0	0	0	?	0	1	0	?	?	2
3	0	2	0	0	?	?	?	0	0	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	1
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	1	?	?	2	?	?	1
?	?	?	?	?	?	?	?	?	?	?
?	1	1	[01]	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	1	?	?
?	[01]	2	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
-	-	-	-	-						
cf_Hamadasuchus_rebouli			0	5	0	0	?	0	2	0
0	0	1	0	0	2	0	0	?	0	?
1	1	1	2	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0	2	0	0
0	0	0	0	1	?	0	0	2	2	1
0	0	1	1	?	0	?	0	1	1	2
0	0	0	0	0	?	0	0	0	0	0
0	1	0	0	0	0	0	0	0	1	0
1	0	1	1	1	0	0	0	0	0	0
0	0	2	0	0	0	0	0	0	0	0
-	0	0	0	0	0	0	1	1	0	?
0	1	0	0	0	0	0	0	0	?	1
1	1	1	0	0	0	0	1	?	2	2
0	0	0	0	0	1	0	0	0	0	-
-	[12]	0	1	0	1	3	0	1	0	0
?	1	0	1	1	1	1	0	2	0	2
1	0	?	?	0	1	0	0	2	?	0
1	1	?	1	1	?	2	?	1	1	0
1	0	?	?	?	?	0	1	1	0	0
?	?	1	0	?	1	0	0	0	1	0
0	0	?	0	1	1	1	1	?	0	0
3	1	3	?	0	0	0	?	?	?	?
?	0	0	2	?	?	?	?	?	?	1
?	?	?	0	?	?	?	?	?	?	?
0	?	0	?	?	?	?	?	?	?	?
0	2	1	1	?	?	0	0	0	?	?
2	?	?	0	1	?	?	0	1	?	1
1	?	0	0	?	?	0	1	0	0	0
?	1	1	0	1	0	1	?	0	0	0
0	0	0	0	0	0	1	0	?	?	2
3	0	2	0	0	?	?	?	0	?	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?

?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
-	-	-	-	-						
Sebecus_icaeorhinus		0	5	0	0	?	?	2	0	0
0	1	0	0	?	0	?	?	?	?	1
1	?	2	0	0	0	0	0	0	0	?
0	?	?	1	0	?	?	2	?	?	?
?	?	0	?	?	0	0	2	2	1	0
0	?	1	?	?	0	0	1	1	2	?
0	0	0	?	?	0	?	?	0	0	0
0	0	-	-	-	0	1	-	-	-	-
0	1	1	1	0	0	0	0	?	0	0
0	2	0	0	0	0	0	0	?	0	-
0	0	0	0	?	?	1	?	?	?	0
0	0	0	0	0	0	?	?	?	1	1
1	?	?	?	0	?	?	?	?	2	0
0	0	0	0	1	0	0	0	0	-	-
[12]	0	1	0	1	?	?	1	0	?	?
?	0	?	1	?	?	?	2	?	?	?
0	?	?	?	?	?	0	2	?	0	1
?	?	1	1	?	2	?	?	?	0	1
?	1	?	?	0	?	1	1	?	0	?
?	?	0	0	1	0	0	0	?	0	0
0	?	?	1	1	1	?	?	?	?	2
?	?	?	?	?	?	0	0	1	1	?
?	?	?	0	0	2	?	?	?	?	?
?	?	0	?	?	?	?	1	?	?	?
1	0	?	?	1	1	?	0	0	0	0
2	0	?	?	?	0	?	0	?	?	2
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	2	0	0	0	?
1	1	0	1	0	0	0	0	0	0	0
0	0	0	?	0	1	0	?	?	2	3
0	2	0	0	?	?	?	0	0	0	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	2	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	?	?	0	0	?	?	0	?	?	?
?	?	?	?	?	0	1	1	1	1	1
1	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	-
-	-	-	-							

Mahajangasuchus_insignis			1	?	?	0	?	?	0	0
0	0	1	0	0	2	0	0	?	?	?
1	?	1	?	?	?	1	0	0	0	0
?	0	?	?	1	?	0	?	?	?	?
0	?	?	?	?	?	?	0	1	?	?
?	?	?	?	?	1	0	0	?	1	2
?	0	0	0	?	?	0	2	-	0	0
0	1	0	0	1	0	0	1	0	1	0
1	0	1	1	1	?	0	0	2	4	0
0	0	2	0	0	0	0	0	0	1	0
-	0	0	0	0	?	?	1	1	1	?
0	0	0	0	0	0	0	0	0	?	1
1	1	1	1	0	0	0	?	?	?	1
0	0	0	0	0	0	0	0	0	0	-
-	?	0	1	0	0	3	0	1	0	0
?	?	0	1	1	?	?	?	2	0	?
?	0	?	?	?	?	?	?	2	?	1
1	1	?	2	1	?	0	?	?	1	?
?	?	0	?	?	?	0	1	1	?	0
?	?	1	0	0	1	0	0	?	1	?
?	?	?	?	?	?	?	1	?	?	0
?	1	3	?	0	0	0	1	0	0	0
1	?	?	2	?	?	2	3	1	2	1
?	?	?	0	?	?	0	0	0	?	0
0	1	0	?	?	1	?	1	0	?	?
0	?	0	2	?	?	?	?	0	?	?
3	?	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	1	1	0	0	0
?	1	1	[01]	0	0	?	0	?	0	0
?	?	0	0	0	0	1	0	?	?	2
3	0	2	0	0	?	?	?	0	0	0
?	?	?	?	?	0	0	0	?	?	?
0	?	?	?	?	?	?	?	?	?	?
0	?	?	?	?	?	?	0	?	?	0
0	0	?	0	?	?	?	1	0	0	1
?	0	0	0	0	?	0	0	?	?	?
?	?	?	?	1	1	0	2	?	?	1
?	0	0	0	0	0	?	?	?	1	0
?	1	1	0	1	1	0	?	?	1	?
?	?	?	?	?	?	?	?	1	?	?
?	[01]	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
-	-	-	-	-						
Alligatorium_meyeri			?	?	?	?	?	0	0	0	0
0	1	0	0	2	?	?	?	?	?	?
?	?	?	1	1	1	0	0	0	0	1
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0	0	0	0	0	?	0	?	0	0	?
?	?	?	?	?	?	?	?	?	?	?
0	1	1	?	0	0	0	1	0	0	0

	0	2	0	0	0	?	0	0	?	0	-
	0	0	0	0	2	0	0	0	0	0	1
	2	0	0	0	0	0	0	0	?	1	?
	?	1	0	0	0	0	?	?	?	1	0
	0	0	0	0	0	0	0	0	0	-	-
	1	0	1	0	0	2	?	1	?	?	0
	1	0	1	2	0	?	?	?	?	?	?
	?	?	?	?	?	?	?	?	?	?	?
	?	?	?	?	?	?	?	?	?	?	?
	?	?	?	?	?	?	?	?	?	?	?
	?	?	?	?	?	?	?	?	?	?	?
	?	?	?	?	?	?	?	?	?	?	?
	?	?	?	0	0	0	?	0	1	0	1
	0	0	0	?	?	2	0	0	2	?	?
	?	?	?	?	?	0	0	0	?	0	?
	?	0	?	?	1	1	?	?	?	?	0
	?	?	?	?	?	?	?	0	?	?	?
	?	?	0	?	?	?	?	?	?	?	?
	?	?	?	?	?	0	1	0	0	?	?
	1	?	0	?	0	?	?	0	0	0	0
	0	0	0	0	1	?	?	?	?	?	?
	?	?	0	0	?	?	?	0	?	0	?
	?	?	?	?	0	0	0	?	?	?	0
	?	?	?	?	0	?	?	?	?	?	0
	-	?	?	?	?	-	?	?	?	?	?
	?	?	?	?	?	?	?	?	?	1	?
	?	?	0	0	0	0	0	?	?	0	1
	0	0	1	?	?	?	?	?	?	?	?
	?	?	?	?	?	?	?	?	?	?	?
	0	0	1	1	?	?	?	?	?	?	?
	?	0	0	0	?	?	2	1	?	1	?
	?	?	0	1	?	0	0	0	0	2	0
	0	?	?	?	?	?	0	1	?	?	-
	-	-	-	-							
Theriosuchus_pusillus		1	[12]	?	1	?	0	0	0	0	
	0	1	0	0	2	0	0	?	?	?	1
	1	1	2	1	?	1	0	0	0	0	1
	0	0	0	1	0	0	?	2	0	0	?
	0	0	2	1	?	0	0	2	2	1	0
	0	1	1	?	0	0	0	?	0	2	0
	0	0	0	0	?	0	0	?	0	0	0
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	0	1	1	1	0	0	0	0	0	0	0
	0	2	0	0	0	?	0	0	?	0	-
	0	0	0	0	1	0	1	?	0	?	1
	2	0	0	0	0	0	0	0	?	1	1
	1	1	0	0	0	?	1	?	?	1	0
	0	0	0	0	0	0	0	0	0	-	-
	1	0	1	0	0	2	0	1	0	1	0
	1	0	?	1	2	?	?	2	0	2	1
	0	?	?	0	0	0	1	2	?	0	1
	0	?	1	1	?	0	?	?	?	0	1

?	?	?	?	0	?	1	1	0	0	?
?	?	0	0	2	0	0	0	1	0	0
0	?	?	1	1	1	?	?	0	0	2
?	3	?	0	0	0	0	0	1	?	?
0	0	0	0	2	2	?	0	2	0	?
1	0	0	0	0	0	?	0	1	0	0
1	0	?	0	?	?	?	0	0	0	0
1	[12]	?	?	?	0	0	0	?	?	1
?	?	0	?	?	?	?	?	?	?	?
0	0	0	2	?	0	?	?	0	0	?
1	0	0	?	0	0	0	0	0	0	0
0	0	0	0	?	1	0	?	1	2	0
-	?	0	0	?	?	?	0	0	0	?
0	1	?	0	0	0	?	?	?	?	0
0	0	?	?	?	?	?	1	0	0	0
?	0	0	0	0	?	?	0	?	0	0
0	?	0	2	?	?	1	?	0	?	0
0	0	0	0	?	?	?	0	0	?	1
0	0	?	1	1	0	2	1	?	?	?
0	0	0	0	0	?	?	?	?	0	?
[01]	0	1	?	1	0	?	?	1	1	1
1	0	0	0	0	?	?	1	?	1	?
[01]	?	0	0	?	0	0	0	0	2	0
0	?	?	0	0	0	1	1	?	?	-
-	-	-	-							
Eutretauranosuchus_delfsi			1	1	0	1	?	0	0	0
0	0	1	0	0	2	0	0	?	?	?
?	?	?	2	1	?	1	0	1	0	0
1	0	0	?	?	?	0	?	2	?	?
?	0	0	?	1	?	0	0	2	?	1
0	1	?	1	?	0	0	0	1	0	2
0	1	1	0	0	0	0	0	1	0	1
0	0	0	-	0	-	0	0	-	-	-
-	0	1	1	1	0	0	0	0	0	0
0	0	2	0	0	0	0	0	0	?	0
-	0	0	0	0	0	0	0	?	0	?
0	1	0	0	0	1	0	0	0	?	1
1	1	1	0	0	0	0	1	?	2	1
0	0	0	0	0	0	0	0	0	0	-
-	1	0	1	0	0	?	0	1	0	1
0	1	0	1	0	2	?	?	2	0	2
1	0	?	?	0	1	0	?	2	0	0
1	0	?	1	1	?	0	?	1	1	0
1	0	0	?	?	0	0	1	1	0	0
?	?	1	?	0	2	0	0	0	1	0
0	0	?	0	1	1	1	1	?	?	0
2	1	2	?	?	?	?	0	?	1	1
0	?	?	?	?	?	2	0	0	2	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	?	?	1	?	?	?	0	0	?	?
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Goniopholis_kiplingi 1 2 1 1 ? 0 0 0 0
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?	1	2	1	1	1	0	1	?	1	1
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1	1	1	0	0	0	0	1	0	2	0
1	1	1	0	0	?	0	1	0	1	0
0	0	-	-	-	0	0	-	-	-	-
0	1	1	?	0	0	0	0	1	0	0
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1	2	1	?	?	0	0	0	?	?	?
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1	?	0	?	0	1	?	0	0	0	0
0	0	0	0	?	1	0	?	2	0	0
-	0	0	0	?	4	1	0	?	0	0
?	?	?	?	?	?	?	?	?	?	?
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Goniopholis_simus		1	2	1	1	?	0	0	0	0
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0	0	-	-	-	0	0	-	-	-	-
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0	0	0	0	1	0	0	0	0	?	0

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1 0 ? ? 1 3 ? 1 0 ? ?
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1 2 0 0 0 0 0 0 1 1 0
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Anteophthalmosuchus_hooleyi 1 2 1 1 ? 0 0 0
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1 0 ? 1 1 ? 0 0 1 1 0
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0	0	?	0	?	?	?	?	?	0	0
2	1	2	?	?	?	?	0	0	2	1
0	0	0	0	0	2	0	-	-	2	0
0	1	0	0	0	1	0	?	0	0	?
?	1	?	?	?	?	?	?	?	?	?
0	?	?	1	?	?	?	?	0	?	?
?	0	1	0	1	1	0	1	0	?	0
0	0	0	0	?	?	?	1	0	0	0
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0	-	0	0	0	?	4	1	0	0	0
0	?	?	?	?	0	0	?	?	?	?
0	?	?	?	?	?	?	?	?	0	?
0	?	?	?	?	?	?	?	?	?	?
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0	?	?	0	?	?	?	?	?	?	?
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0	1	0	0	0	?	0	0	0	?	0
1	?	0	?	?	?	0	?	?	?	?
1	1	?	?	?	?	?	?	1	1	1
1	?	?	?	1	?	0	0	0	0	2
1	0	1	?	?	?	?	?	?	?	?
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Anteophthalmosuchus_epikrator				1	2	1	1	?	0	0	0
0	0	1	0	0	2	0	?	?	?	?
?	?	1	2	1	1	1	0	1	0	1
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1	1	0	?	1	?	0	0	2	2	1
0	1	1	1	0	0	0	0	1	0	2
0	1	1	1	0	0	?	0	1	0	1
0	0	0	-	-	-	0	0	-	-	-
-	0	1	1	1	0	0	0	0	1	0
0	0	1	0	0	0	0	0	0	0	0
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0	0	0	0	0	2	1	0	0	0	1
1	1	1	0	0	0	0	1	0	2	1
0	0	0	1	0	0	1	0	0	0	-
-	1	0	0	0	0	?	?	1	1	1
0	1	0	1	1	2	1	0	2	0	?
1	?	?	2	?	1	0	1	2	?	?
1	0	?	?	?	?	?	0	1	1	0
1	0	0	0	?	?	0	1	1	0	0
?	?	?	0	0	2	0	?	0	1	0
0	0	?	0	1	?	?	1	1	0	0
2	1	2	?	?	?	?	0	0	1	1
0	0	0	0	?	?	0	-	-	2	0
?	?	?	?	?	?	?	?	?	0	?
1	1	?	?	1	1	?	?	1	0	?
0	1	[23]	1	?	?	1	0	0	0	0
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?	1	0	?	?	0	1	1	0	0	0

0	0	0	0	?	0	1	0	?	2	0
0	-	0	0	0	?	4	1	0	0	0
0	?	?	?	?	0	0	?	?	?	?
0	?	0	?	?	?	0	0	0	0	0
?	?	0	0	0	0	?	?	?	?	0
0	0	?	0	2	0	0	0	0	0	2
0	0	0	0	0	?	0	0	0	0	0
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1	1	?	?	0	0	?	2	1	1	1
1	?	?	?	1	0	0	0	0	0	2
1	0	1	?	?	0	1	0	?	?	?
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Elosuchus_cherifiensis	1	2	1	1	?	1	1	0	0	
0	3	0	0	2	0	0	?	?	?	?
?	?	2	1	1	?	0	0	?	0	1
0	?	0	?	0	0	0	2	0	0	2
2	0	?	1	?	0	0	1	2	?	?
?	1	1	?	0	0	?	1	?	1	0
1	0	0	0	?	?	0	2	0	1	0
0	0	-	-	-	0	0	-	-	-	-
0	1	1	?	0	0	0	0	2	0	0
0	1	0	0	0	0	0	0	0	0	-
0	0	0	0	0	1	0	?	1	0	1
0	0	0	0	2	0	0	0	0	1	1
?	1	0	0	0	0	1	0	2	1	0
1	0	0	0	0	0	0	0	0	-	-
?	0	1	0	0	3	0	1	0	1	0
2	0	1	0	0	1	1	2	0	2	1
0	?	?	0	0	0	?	2	0	?	1
0	?	2	?	?	?	0	1	1	0	1
1	?	0	0	0	?	1	1	0	0	?
?	?	?	?	2	0	0	0	1	0	1
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1	2	?	?	?	?	?	?	?	1	?
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Elosuchus_broinae 1 2 1 1 ? 1 1 0 0
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Vectisuchus_leptognathus 1 [12] ? 1 ? 0 1 0
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1 0 ? ? 1 ? 0 ? ? ? ?

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0	0	0	-	-	-	0	0	-	-	-
-	0	1	1	?	0	0	0	0	2	0
0	0	1	0	0	0	?	0	0	0	0
-	0	0	0	0	?	1	0	?	1	?
1	0	0	0	0	2	?	?	0	?	0
1	?	1	0	0	0	0	?	?	?	?
0	2	1	0	0	0	0	0	0	0	-
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0	2	0	?	1	?	?	?	2	0	2
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0	?	?	?	?	?	?	?	0	?	?
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1	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	?	?	?	?	?	?
-	-	-	-	-						
Pholidosaurus_schaumburgensis				1	0	1	1	?	1	1
0	0	0	1	0	0	2	0	0	?	?
?	1	?	?	2	1	?	?	0	0	-
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?	?	?	?	?	?	?	?	0	?	?
?	?	?	?	1	?	0	0	0	1	?
0	?	1	0	0	1	0	0	0	1	0
1	0	0	0	-	-	-	0	0	-	-
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0	0	0	2	0	0	0	?	0	0	?
0	-	0	0	0	0	?	1	0	0	0
?	0	0	0	?	0	2	0	0	0	0
1	1	1	1	0	0	0	0	?	?	?

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-	-	1	?	1	0	0	1	0	1	0
?	0	?	?	?	1	2	1	?	2	?
2	1	0	0	?	0	0	0	1	2	0
0	1	0	?	?	1	0	0	0	1	?
?	?	?	?	?	?	?	?	1	1	0
0	?	?	?	?	?	2	0	0	0	?
?	?	?	?	?	1	1	1	1	?	?
0	2	1	2	?	0	0	0	0	0	1
1	1	0	1	0	1	2	?	?	?	?
?	?	?	?	?	?	1	?	?	?	?
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?	0	1	4	1	?	?	0	2	0	?
?	0	?	?	0	?	?	?	?	?	?
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?	0	0	?	0	1	0	1	1	0	0
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0	0	-	?	0	0	0	4	?	0	0
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1	?	[01]	?	?	1	?	0	0	?	?
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Pholidosaurus_sp_(Charente)			1	2	1	1	2	1	1	0
0	0	3	0	0	2	0	0	?	?	?
?	?	?	2	1	?	?	?	0	-	0
1	0	0	0	1	0	0	0	2	0	0
1	1	0	0	1	1	0	0	1	2	1
0	1	0	1	?	0	0	0	1	0	0
0	1	0	0	1	?	?	0	1	0	1
0	0	0	-	-	-	0	0	-	-	-
-	0	1	1	1	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0
-	0	0	0	0	0	1	0	0	0	0
1	0	0	0	0	2	0	0	0	0	1
1	1	1	0	0	0	0	1	0	2	1
0	1	0	0	0	0	0	0	0	0	-
-	?	0	1	0	0	1	0	1	0	1
0	2	0	1	1	2	?	?	2	0	2
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0	0	?	2	1	?	0	0	1	1	0
1	0	0	0	?	0	0	1	1	0	0
?	?	?	0	0	2	0	0	0	1	0
1	0	0	0	1	?	?	1	?	0	0
2	1	2	?	0	?	0	0	0	1	1

1	0	1	0	1	?	1	2	0	2	0
0	0	-	-	-	1	?	0	?	?	?
0	?	?	?	?	1	1	?	?	?	0
0	1	3	1	?	?	0	1	0	0	0
1	0	0	0	1	0	1	0	0	?	0
0	0	0	0	0	?	?	?	?	0	?
?	?	?	0	1	0	1	1	0	0	0
0	0	0	0	?	1	1	0	?	?	0
0	?	?	0	0	?	4	0	0	0	0
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Meridiosaurus_vallisparadisi			?	?	?	?	?	2	1	0
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1	0	0	0	1	0	0	1	2	0	0
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2	1	-	?	?	0	?	?	?	0	2
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Chalawan_thailandicus	1	?	?	?	?	1	0	0	1	
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cf_Terminonaris_robusta 1 ? ? 0 ? 1 1 0
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?	2	0	?	1	2	?	?	2	0	2
1	?	0	?	0	0	0	?	2	0	0
?	?	?	2	?	?	2	0	1	?	0
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?	1	?	?	0	0	0	0	0	1	?
?	0	1	0	1	?	1	?	0	2	?
?	?	?	0	0	?	0	0	0	0	0
?	?	?	?	?	1	1	0	?	?	?
0	1	?	1	?	?	0	3	0	?	?
0	?	?	?	?	?	?	0	0	0	1
0	?	0	0	?	?	0	1	0	?	?
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0	0	0	0	?	1	1	0	?	?	0
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1	0	0	1	1	1	?	?	1	0	1
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1	1	0	?	0	?	?	?	1	?	1
1	1	2	0	1	?	0	0	0	0	2
1	0	?	?	?	?	?	?	?	?	?
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Oceanosuchus_boecensis			1	?	1	?	?	1	1	0
0	?	1	0	0	2	?	?	?	?	?
?	?	?	2	1	?	1	0	0	0	0
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1	2	0	0	1	?	0	0	?	2	1
0	1	0	1	?	0	?	0	1	?	0
?	?	0	0	?	?	?	0	0	0	0
?	0	0	-	-	-	0	0	-	-	-
-	0	1	1	?	0	0	0	0	0	0
0	0	0	0	0	0	?	0	?	0	0
-	0	0	0	0	0	1	0	0	0	?
0	0	0	0	0	2	0	0	0	0	1
?	?	1	0	0	0	0	1	0	2	1
0	0	0	0	0	?	?	?	?	?	-
-	1	?	?	?	0	?	0	1	0	?
?	?	0	?	?	?	?	?	?	?	2
1	?	?	?	?	?	?	1	2	?	?
?	?	?	?	?	?	?	0	1	1	0
1	0	0	0	0	0	?	1	1	0	0
?	?	1	?	?	?	0	0	0	1	0
1	0	0	0	?	?	?	1	?	0	0
?	?	?	?	0	0	0	?	0	1	?
?	0	1	0	1	?	0	-	-	2	?
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0	1	2	1	?	?	0	3	0	0	0
1	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	1	1	0	?	?
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0	0	0	0	?	1	1	0	?	?	0
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0	?	1	?	?	?	0	0	?	?	?
0	0	0	?	?	?	?	?	?	0	?
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1	0	?	?	?	?	?	?	1	?	?
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Pholidosaurus_purbeckensis			1	1	1	1	?	1	1	0
0	0	3	0	0	1	0	0	?	?	?
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0	1	0	0	0	0	?	0	1	0	1
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-	0	1	1	1	0	0	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0
-	0	0	0	0	0	1	0	0	0	0
0	0	0	0	2	2	0	0	0	0	1
1	1	1	1	0	0	0	1	0	2	1
1	0	0	0	1	1	0	0	0	0	-
-	1	0	0	0	0	2	0	1	0	1
0	2	0	1	1	2	?	?	2	0	2
1	?	0	?	?	?	?	?	2	0	0
1	0	?	2	1	?	0	0	1	1	3
1	0	0	0	0	0	0	1	1	0	0
?	0	1	?	0	2	0	0	0	1	0
1	0	0	0	1	1	1	1	1	0	?
2	1	3	?	?	?	?	?	?	?	?
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0	?	?	?	?	1	?	?	?	?	?
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1	?	?	0	1	?	0	0	0	0	2
1	0	1	?	?	?	?	?	?	?	?
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Fortignathus_felixi		?	?	?	?	?	[12]	?	?	0
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Acherontisuchus_guajiraensis ? ? ? ? ? 1 1 ?
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1	1	1	0	0	0	0	1	0	?	1
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-	?	0	0	0	1	?	?	1	?	?
?	?	?	1	?	?	1	?	2	0	2
1	?	?	5	0	1	0	0	2	?	?
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Arambourgisuchus_khouribgaensis				1	?	?	0	?	1	1
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1	2	0	0	2	2	1	0	0	0	0
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0	0	0	0	0	0	0	0	0	0	-
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0	0	0	?	?	1	0	1	1	1	1
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?	?	?	0	0	?	0	0	1	0	?
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Dyrosaurus_phosphaticus			1	?	?	0	?	1	1	0
0	0	1	0	0	2	0	?	?	?	?
?	?	?	?	1	0	0	0	0	-	0
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?	0	0	1	1	?	0	0	?	2	1
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1	0	?	2	?	?	2	2	1	?	3

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?	1	3	?	?	?	0	0	0	1	?
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0	2	2	0	?	?	1	0	0	?	?
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1	?	?	?	?	?	?	?	?	?	?
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Guarinisuchus_munizi		1	5	1	0	?	1	1	0	0
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1	?	?	?	?	?	?	?	?	?	0
2	1	0	?	?	1	0	0	?	?	2
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-	?	0	0	0	0	0	1	1	0	1
0	2	0	1	0	?	?	?	2	0	2
1	?	?	?	0	0	0	1	2	1	1
1	0	0	2	?	0	2	2	1	1	3
1	0	1	0	0	0	0	1	1	1	0
0	?	?	0	0	2	0	1	0	1	1
1	1	1	1	?	1	1	1	1	0	1
?	1	3	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	0	?	?	?	?	?	?	?
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?	?	?	?	?	?	0	?	0	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	1	?	?	?	?	?
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Sabinosuchus_coahuilensis			?	?	?	?	0	1	?	0
0	0	0	2	?	?	?	?	?	?	?
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?	0	0	-	-	-	0	0	-	-	-
-	0	?	?	?	?	?	?	?	?	?
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?	0	0	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	0	?
1	?	?	?	?	?	?	0	2	?	?
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1	0	0	?	1	3	0	-	-	2	0
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2	?	?	0	1	0	0	0	2	?	1
0	0	1	1	0	?	?	?	?	?	?
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0	0	0	0	0	?	?	?	?	?	?
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Sokotosuchus_ianwilsoni			?	?	?	?	2	1	0	0
0	0	1	1	1	2	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
1	0	1	1	1	?	?	0	?	1	0
1	1	0	1	?	?	0	0	1	2	1
0	1	1	?	?	?	0	?	?	0	1
?	?	0	0	?	?	?	?	?	?	?
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-	0	1	1	1	0	0	0	0	0	0
0	1	0	0	0	0	?	1	0	0	0
-	?	?	?	?	0	?	?	?	?	0
0	2	0	?	?	2	0	?	?	0	1
?	?	1	1	0	0	0	?	0	?	1
0	0	0	?	0	?	?	?	?	?	?
?	?	?	?	?	?	1	?	1	0	1
0	2	?	?	?	?	?	?	?	0	2
1	?	?	?	0	0	?	?	?	?	?
?	?	?	?	?	?	?	2	?	?	3
1	1	?	?	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	0	?	?	?	?	?	?	?
?	1	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	2	1	0	?	?	1	0	0	0	?
?	0	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	0

0	0	0	0	?	1	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
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Bernissartia_fagesii		1	1	0	1	?	0	0	0	0
0	1	?	0	2	0	0	?	?	?	?
?	1	2	1	?	?	0	0	?	0	0
0	?	0	1	0	0	0	2	?	0	?
0	0	?	1	?	0	0	2	2	1	0
0	1	1	?	0	0	0	?	0	2	0
0	0	0	0	0	?	?	?	0	0	0
0	0	-	-	-	0	0	-	-	-	-
0	1	1	?	0	0	0	0	0	0	0
0	2	0	0	0	?	0	0	0	0	-
?	?	?	?	0	0	?	?	?	?	1
2	0	?	?	0	0	0	0	?	?	?
?	1	0	0	0	?	?	?	?	1	0
0	0	?	?	?	?	?	?	0	-	-
?	0	?	?	?	2	?	1	?	?	0
?	0	?	?	?	?	?	2	0	2	1
0	?	?	?	?	?	?	2	?	?	1
0	?	2	1	?	?	?	1	1	0	?
?	?	?	?	?	0	1	1	?	?	?
?	1	?	?	2	?	?	?	?	?	?
?	?	?	?	?	?	1	?	?	0	?
1	?	?	0	0	0	0	0	1	1	1
0	0	0	0	3	0	-	-	2	0	?
?	?	?	?	?	0	?	0	?	?	0
1	?	?	?	1	?	0	?	?	?	0
1	1	1	?	?	0	0	0	?	?	2
?	?	0	?	?	?	?	?	?	?	0
0	?	?	?	?	?	1	?	?	0	0
1	0	0	1	0	1	1	0	0	0	1
0	0	0	0	?	0	-	0	-	-	0
-	0	0	0	?	?	?	0	0	0	0
?	?	?	?	0	0	?	?	?	?	0
?	?	?	?	?	0	?	1	2	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	1	?
?	?	?	0	?	0	0	0	0	?	?
?	?	?	1	1	0	2	1	?	1	0
?	?	?	?	?	?	?	?	1	0	1

0 0 1 1 1 0 ? ? ? ? ?
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1 2 0 0 ? 0 1 0 0 2 0
0 1 ? 0 ? 1 0 1 ? ? -
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Koumpiodontosuchus_aprosdokiti 1 1 0 ? ? 0 0
0 0 0 1 1 0 2 0 0 ? ?
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? ? 0 0 0 1 0 0 0 ? ?
1 0 1 ? 1 0 0 0 0 0 0
2 0 0 0 0 0 0 ? 0 ? 0
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- - 0 1 1 1 0 0 0 0 0
0 0 0 2 0 0 0 1 0 0 0
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1 0 0 0 0 0 0 0 0 0 0
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2 1 0 0 ? 0 1 0 1 2 0
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Susisuchus_anatoceps 1 1 0 1 ? 0 0 0 0
0 1 0 0 2 ? ? ? ? ? ?
? ? ? 1 ? 1 0 0 - 0 1
4 ? ? 1 0 0 ? 2 ? ? ?

?	?	1	1	?	0	0	1	2	1	0
1	?	1	?	?	0	0	?	?	0	?
0	0	0	0	?	?	2	-	0	0	0
0	0	-	-	-	0	0	-	-	-	-
0	1	1	1	0	0	0	0	0	0	0
0	2	0	?	0	?	0	0	?	0	-
0	0	0	?	0	0	0	0	0	0	0
?	0	0	0	0	0	0	0	?	?	?
?	?	?	?	0	?	?	?	?	1	0
0	0	0	0	0	0	0	0	0	-	-
?	0	1	0	0	?	?	1	0	?	0
1	0	?	2	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	?
1	?	0	?	?	?	?	?	1	?	?
0	0	0	?	?	?	?	?	?	?	?
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1	?	?	?	?	0	?	0	?	?	?
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?	?	?	?	?	?	?	?	?	0	?
?	?	0	0	?	0	0	?	?	?	0
0	0	?	?	?	0	?	?	?	0	?
?	0	0	0	0	?	?	0	?	0	?
?	?	0	?	?	?	?	0	0	1	?
0	0	0	0	0	0	0	?	?	?	1
0	0	1	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	1	?	1	1
2	2	1	0	?	1	1	0	0	?	0
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Isisfordia_duncani		1	1	0	1	?	0	0	0	0
0	1	0	0	2	0	0	?	?	?	?
?	?	2	?	?	?	0	?	-	0	1
4	0	?	1	0	0	0	2	?	?	0
0	0	1	1	?	0	0	1	2	1	0
1	?	1	?	?	0	0	1	?	0	?
0	0	0	0	?	?	?	1	0	0	0
0	0	-	-	-	0	0	-	-	-	-
0	1	1	1	0	0	0	0	0	0	0
0	2	0	0	0	0	0	0	0	0	-
0	0	0	0	1	0	1	?	0	0	0
2	0	0	0	0	0	0	0	?	1	1
1	1	0	0	0	?	1	?	?	1	0

0	0	0	0	0	0	0	0	0	-	-
?	0	1	0	0	?	?	1	0	1	0
1	0	1	2	2	?	?	2	0	2	1
?	?	?	0	1	0	1	2	?	0	1
0	?	2	1	0	0	?	1	?	0	1
0	0	?	?	0	0	1	1	?	0	?
?	?	0	0	2	0	0	0	?	0	0
?	?	?	?	1	1	1	?	?	?	?
1	3	?	0	0	0	?	?	?	?	?
0	0	0	?	?	2	[01]	0	2	?	?
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?	?	?	?	1	?	0	?	?	?	0
1	2	1	?	?	0	0	0	?	?	?
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0	0	0	?	1	1	0	?	?	?	0
-	?	0	0	?	?	?	0	0	0	?
?	?	0	0	0	1	0	?	?	?	1
0	0	?	?	?	0	?	?	?	0	?
?	0	0	0	0	?	?	0	?	?	0
0	0	0	?	?	?	0	0	0	1	0
0	0	0	0	0	0	0	?	?	?	?
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0	0	0	0	?	?	?	?	?	?	?
0	0	1	1	1	0	?	?	1	1	?
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2	2	1	0	?	1	1	0	0	?	0
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Pietraroiasuchus_ormezzanoi			1	?	?	1	?	0	0	0
0	0	?	0	0	2	0	0	?	?	?
?	?	?	?	1	?	?	0	?	?	0
1	?	0	0	1	0	0	1	2	0	0
?	0	0	2	1	?	0	0	1	2	1
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1	0	1	1	?	0	0	0	1	0	0
0	0	1	0	0	0	?	0	0	?	0
-	0	0	0	0	0	0	1	1	0	0
1	2	0	?	0	0	0	0	0	?	?
1	?	1	0	0	0	?	?	?	?	1
2	0	0	0	?	0	0	0	0	0	-
-	?	0	1	0	0	?	0	1	0	?
0	?	0	?	2	?	?	?	2	?	2
1	?	?	?	?	?	?	?	2	?	0
?	?	?	2	1	0	0	?	?	?	?
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?	?	?	?	0	0	0	0	0	1	1

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Pachycheilosuchus_trinquei ? ? ? ? ? ? ? ?
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2 0 0 1 2 0 0 0 0 ? 0
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?	?	?	0	0	0	2	?	?	1	0
2	?	?	?	?	?	0	?	1	2	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	0	2	0	?	?	?	0	2
0	0	0	0	0	0	0	0	1	0	?
?	?	?	?	1	1	0	2	1	0	1
0	0	0	0	0	0	?	0	0	?	0
?	0	0	3	1	1	0	?	?	1	?
?	?	?	?	?	?	?	?	1	1	1
?	?	?	1	0	0	1	1	0	0	2
0	0	1	?	?	?	?	?	?	?	?
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Iharkutosuchus_makadii	1	?	?	1	2	0	0	0	0	
0	1	0	0	2	0	0	?	?	?	?
?	1	2	?	?	?	?	0	?	0	0
0	0	0	1	0	0	1	2	0	0	0
0	0	2	1	?	0	0	1	2	1	0
0	-	1	0	0	0	0	1	0	0	?
0	0	0	0	0	?	2	-	0	0	0
0	0	-	-	-	0	0	-	-	-	-
0	1	1	1	0	2	-	-	-	-	-
-	-	-	-	-	-	-	0	-	0	-
0	0	0	0	0	0	1	1	-	-	-
2	-	-	0	0	0	0	0	0	0	0
-	1	-	-	0	0	1	0	2	0	1
0	0	0	?	1	0	0	0	0	-	-
?	0	1	0	0	3	0	1	?	1	0
1	0	1	2	0	1	1	1	1	2	1
0	0	2	0	0	0	0	2	0	0	1
0	?	3	1	1	0	0	1	1	0	1
0	0	0	0	?	0	1	1	?	0	?
?	?	?	0	2	0	?	1	1	?	0
?	?	?	?	?	?	1	1	0	0	2
1	3	?	0	0	0	1	0	2	1	1
0	0	0	0	3	0	-	-	2	0	0
?	?	?	?	2	?	0	?	?	1	?
?	?	?	0	1	?	?	?	?	?	0
1	1	1	?	?	0	0	0	0	0	2
0	1	1	2	1	0	0	0	0	0	0
0	0	0	2	?	0	[12]	0	?	?	?
0	0	0	1	0	1	1	0	0	0	0
0	0	2	0	?	0	0	0	0	0	0
-	0	0	0	?	?	0	0	0	0	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?

? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? -
- - - -
Gavialis_gangeticus 1 1 0 1 ? 1 1 0 0
1 1 0 0 2 0 0 0 0 0 1
1 1 2 1 0 0 0 0 - 0 1
0 0 0 1 0 0 1 2 0 0 ?
0 0 0 1 ? 0 0 1 2 1 2
1 1 1 ? 0 0 0 1 0 0 0
0 0 0 0 0 ? 0 2 0 0 1
0 0 - - - 0 0 - - - -
0 1 1 1 1 0 0 0 4 0 0
0 1 0 0 0 0 0 0 0 0 -
0 0 0 0 0 1 0 0 1 0 0
0 0 0 0 0 0 0 0 0 0 1
1 1 0 0 0 0 ? 0 ? 1 0
2 1 0 1 0 0 0 0 0 - -
1 0 1 0 0 3 0 1 0 1 0
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0 0 ? 0 0 0 1 2 0 1 1
0 ? 3 1 1 0 0 1 1 0 1
0 0 0 0 0 0 1 1 0 1 ?
0 1 0 0 2 0 0 1 1 0 1
? ? 0 0 1 1 1 1 0 0 2
2 3 0 0 0 0 0 0 1 1 0
0 1 0 3 3 2 0 0 2 0 ?
1 0 0 0 1 0 0 0 0 0 0
1 0 0 0 1 1 0 0 0 0 0
1 3 1 ? ? 0 0 0 0 0 1
? ? 0 ? ? ? 0 ? ? ? ?
0 0 0 ? ? 0 1 0 1 0 0
0 0 0 1 0 1 1 0 0 0 0
0 0 0 0 1 1 0 0 0 0 0
- 0 0 0 0 4 0 0 0 0 0
? 0 0 0 0 2 0 ? ? ? 2
0 0 ? ? 0 0 ? 1 2 0 0
- 0 0 0 0 - ? 0 0 0 0
0 0 ? ? ? ? 0 0 0 1 0
0 0 0 0 0 0 0 1 0 0 1
0 0 1 ? ? 0 2 1 0 1 0
0 0 0 0 0 ? ? 0 1 0 1
0 0 2 1 1 0 1 1 1 1 1
1 0 0 0 0 2 2 1 1 1 0
1 1 1 0 0 1 1 0 0 ? 0
1 ? 0 0 0 1 1 1 ? 1 0
0 ? 0 2
Crocodylus_porosus 1 1 0 1 2 0 0 0 0
0 1 0 0 2 0 0 0 0 0 1
1 1 2 1 0 0 0 0 1 0 1
0 0 0 1 0 0 1 2 0 0 ?
0 0 2 1 ? 0 0 2 2 1 0
1 1 1 ? 0 0 0 1 0 2 0

0	0	0	0	0	0	0	1	0	0	0
0	0	-	-	-	0	0	-	-	-	-
0	1	1	1	1	0	0	0	0	0	0
0	2	0	0	0	0	0	0	?	0	-
0	0	0	0	0	1	1	0	1	0	0
0	0	0	0	0	0	0	0	0	0	1
1	1	0	0	0	0	?	0	?	1	0
0	0	0	0	1	0	0	0	0	-	-
1	0	1	0	0	3	0	1	0	1	0
1	0	1	2	2	1	0	2	0	2	1
0	0	?	0	0	0	1	2	0	1	1
0	?	3	1	1	0	0	1	1	0	1
0	0	0	0	0	0	1	1	0	1	0
0	1	0	0	2	0	0	1	1	0	0
?	?	0	0	1	1	1	1	0	0	2
2	3	0	0	0	0	0	0	1	1	1
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1	0	0	0	2	0	0	0	0	0	1
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1	1	1	?	?	0	0	0	0	0	2
?	?	0	?	?	?	0	?	?	?	?
0	0	0	?	?	0	1	0	0	0	?
1	0	0	1	0	1	1	0	0	0	0
0	0	0	0	1	1	0	0	?	2	0
-	0	0	0	?	?	0	0	0	0	0
0	0	0	0	0	2	0	?	?	?	2
0	0	?	?	0	0	?	1	2	0	0
-	0	0	0	0	-	?	1	0	0	0
0	0	0	?	?	?	0	0	0	1	0
0	0	0	0	0	0	0	1	0	0	1
0	0	1	1	1	0	2	1	0	1	2
1	0	0	1	0	?	?	0	1	0	1
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1	0	0	0	0	2	2	1	1	1	0
2	0	1	0	0	1	1	0	0	?	0
1	?	1	0	0	1	1	1	?	1	0
0	1	1	1							
Crocodylus_niloticus		1	1	0	1	2	0	0	0	0
0	1	0	0	2	0	0	0	0	0	1
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0	0	-	-	-	0	0	-	-	-	-
0	1	1	1	1	0	0	0	0	0	0
0	2	0	0	0	0	0	0	?	0	-
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0	0	0	0	0	0	0	0	0	0	1
1	1	0	0	0	0	?	0	0	1	0
0	0	0	0	1	0	0	0	0	-	-
1	0	1	0	0	3	0	1	0	1	0

1	0	1	2	2	1	0	2	0	2	1
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0	?	3	1	1	0	0	1	1	0	1
0	0	0	0	0	0	1	1	0	1	?
0	1	0	0	2	0	0	1	1	0	0
1	?	0	0	1	1	1	1	0	0	2
2	3	0	0	0	0	0	0	1	1	1
0	0	0	0	3	2	0	0	2	0	?
1	0	0	0	2	0	0	0	0	0	1
1	0	0	0	1	1	0	0	0	0	0
1	1	1	?	?	0	0	0	0	0	2
?	?	0	?	?	?	0	0	1	0	?
0	0	0	?	?	0	1	0	0	0	0
1	0	0	1	0	1	1	0	0	0	0
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-	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	2	0	?	?	?	2
0	0	?	?	0	0	?	1	2	0	0
-	0	0	0	0	-	?	1	0	0	0
0	0	0	?	?	?	0	0	0	1	0
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0	0	1	1	1	0	2	1	0	1	2
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0	0	1	1	1	0	1	1	1	1	1
1	0	0	0	0	2	2	1	1	1	0
2	0	1	0	0	1	1	0	0	?	0
1	?	1	0	0	1	1	1	?	1	0
0	1	1	1							
Alligator_mississippiensis		1	1	0	1	2	0	0	0	
0	0	1	0	0	2	0	0	0	0	0
1	1	1	2	1	0	0	0	0	1	0
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0	0	0	2	1	?	0	0	1	2	1
?	0	1	1	?	0	0	0	1	0	2
0	0	0	0	0	0	0	2	-	0	0
0	0	0	-	-	-	0	0	-	-	-
-	0	1	1	1	1	0	0	0	0	0
0	0	2	0	0	0	0	0	0	?	0
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0	2	0	0	0	1	0	0	0	0	1
1	1	1	0	0	0	0	1	0	0	1
0	0	0	0	0	1	0	0	0	0	-
-	1	0	1	0	0	3	0	1	0	1
0	1	0	1	2	2	1	0	2	0	2
1	0	0	?	0	1	0	1	2	0	1
1	0	?	3	1	1	0	0	1	1	0
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0	1	?	0	0	1	1	1	1	0	0
2	2	3	0	0	0	0	0	0	1	1
1	0	0	0	0	0	2	0	0	2	0
?	1	0	0	0	2	0	0	0	0	0

0	1	0	0	0	1	1	0	0	0	0
0	1	1	1	?	?	0	0	0	0	0
2	?	?	0	?	?	?	0	1	1	0
0	0	0	0	3	?	0	1	0	0	0
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0	0	0	0	0	1	1	0	0	0	0
0	-	0	0	0	1	0	0	0	0	0
0	0	0	0	0	0	2	0	?	?	?
2	0	0	?	?	0	0	?	1	2	0
0	-	0	0	0	0	-	?	1	0	0
0	0	0	0	2	0	0	0	0	0	1
0	0	0	0	0	0	0	0	1	0	0
1	0	0	1	1	1	0	2	1	0	1
1	0	0	0	0	0	?	?	0	1	0
1	0	0	1	1	1	0	1	1	1	1
1	1	0	0	0	0	2	2	1	1	1
0	1	1	1	0	0	1	2	0	0	?
0	1	?	1	0	0	1	1	1	1	1
0	1	0	1	0						
Steneosaurus_gracilirostris			1	0	0	0	0	2	1	0
0	0	3	0	0	2	?	?	1	1	?
0	?	0	?	0	1	1	0	0	-	0
1	1	0	0	1	0	1	0	2	0	0
?	0	0	[01]	1	0	0	0	1	2	1
2	1	-	0	0	0	1	?	1	?	0
0	0	0	0	0	0	?	0	1	0	0
?	1	0	1	1	0	1	1	0	0	1
1	0	0	0	0	?	0	1	0	0	0
0	0	1	0	-	0	0	-	0	0	0
-	0	0	0	?	0	0	0	0	0	0
1	0	0	0	0	0	0	1	1	0	1
0	-	1	2	0	0	0	1	0	2	2
1	0	0	0	0	1	0	0	0	0	-
-	0	0	0	0	0	3	0	1	0	0
0	0	1	?	?	?	1	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	?	1	1	1	0
1	0	0	0	?	?	0	1	1	0	0
?	0	?	?	?	?	?	?	?	?	?
0	?	?	[01]	?	?	1	0	?	0	0
?	1	?	?	?	?	?	0	0	0	0
0	0	2	0	?	?	2	1	0	2	0
0	?	?	?	0	?	?	0	?	?	?
?	?	?	?	[01]	1	?	0	?	?	?
0	2	4	?	?	?	0	0	?	?	?
0	0	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	1	?
0	?	?	?	?	0	1	1	0	0	0
0	0	0	0	0	1	?	?	0	?	?
?	?	?	0	0	0	[34]	0	0	0	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	0	?	0	0	?

0	-	?	?	?	?	-	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
1	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	?	0	0	?	?	?	?	?	?
?	0	1	?	2	?	1	?	?	?	?
?	?	?	?	?	?	?	?	1	1	1
1	0	-	0	1	0	0	0	0	0	2
0	?	?	?	?	?	0	?	?	0	?
-	-	-	-	-						
Steneosaurus_brevior		1	?	?	?	1	0	1	0	0
0	3	0	?	?	?	?	?	?	?	?
?	?	?	1	1	1	0	0	-	0	0
1	0	0	1	0	1	0	2	0	0	?
0	1	1	1	0	0	0	1	2	1	2
1	-	0	0	0	1	0	1	0	0	0
0	0	0	0	0	?	0	1	0	0	0
1	0	0	0	0	0	0	0	0	1	1
0	0	0	0	?	0	1	0	[01]	1	0
0	0	0	-	[01]	0	-	0	0	0	-
0	0	0	0	0	0	0	0	0	0	1
0	?	0	0	0	0	1	1	?	?	?
?	?	?	?	?	0	?	?	2	1	0
0	0	0	0	1	0	0	1	0	-	-
0	0	?	0	0	3	0	1	0	0	0
0	1	?	?	?	1	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	?	?	?	?	0	1
0	?	?	?	?	?	?	?	?	0	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	0	0	0	0	0	0	1	1
0	2	0	2	?	2	0	0	2	0	0
?	?	?	0	?	?	?	1	1	?	?
?	0	1	0	?	?	?	?	?	?	0
2	4	?	1	?	0	0	0	0	?	1
[01]	0	0	1	0	0	0	0	1	0	0
1	?	?	?	?	0	?	0	[01]	?	0
1	0	0	0	0	1	1	0	0	0	0
0	0	0	0	1	?	?	0	?	?	?
?	?	0	0	0	4	0	0	0	0	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	0	?	?

? ? ? ? ? ? ? ? ? ? -
- - - -
Chinese_teleosauroid 1 3 1 0 1 0 1 0 0
0 0 0 0 2 0 0 1 1 ? ?
2 ? 2 ? 1 1 0 0 - 0 0
1 0 0 1 0 1 0 2 0 0 0
0 1 0 1 0 0 0 1 2 1 2
1 - 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 0 1 0 0 0
1 0 0 0 0 0 0 0 0 1 1
0 0 0 0 0 0 1 0 0 1 0
0 0 0 - 0 0 - 0 0 0 -
0 0 0 0 0 0 0 0 0 0 1
1 0 0 0 0 0 1 1 0 1 0
- 1 2 0 0 0 1 0 2 1 1
0 0 0 0 1 0 0 1 ? - -
0 0 ? 0 0 3 0 1 0 0 0
0 1 ? 0 ? 1 0 2 1 2 1
1 0 ? 0 ? 0 0 2 0 0 1
0 0 1 1 0 1 1 1 1 0 1
0 0 0 0 0 0 1 1 0 0 ?
0 0 0 1 0 0 0 0 1 0 1
0 0 0 0 ? ? 0 ? 0 0 ?
1 1 1 ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? 0
2 3 1 0 0 1 0 0 0 0 ?
0 0 ? ? ? ? ? ? ? ? ?
? ? ? ? ? 0 ? ? ? ? ?
? ? ? ? 0 ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? 4 ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
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? ? ? ? ? ? ? ? ? ? -
- - - -
Platysuchus_multiscrobiculatus 1 5 0 0 1 2 1 0
0 0 3 0 0 2 ? 0 ? ? ?
? 2 ? ? 0 1 1 0 0 - 0
0 1 0 0 1 0 1 0 2 0 0
? ? 1 1 1 ? 0 0 ? 2 1
2 1 - 0 0 0 1 0 1 0 0
? 0 0 0 0 ? 0 0 1 0 0

0	1	0	0	0	0	0	0	0	0	1
1	0	0	0	?	?	0	1	0	0	1
0	0	0	0	-	0	0	-	0	0	0
-	0	0	0	0	0	0	0	0	0	0
1	0	1	1	0	0	0	1	1	?	?
0	-	1	2	0	0	0	?	?	?	1
1	0	0	0	0	1	0	0	1	1	-
-	0	0	?	?	?	3	0	1	0	?
0	?	1	?	0	?	?	?	?	?	?
?	?	?	?	?	?	?	0	?	?	?
?	?	0	?	?	?	?	?	?	1	?
?	0	?	?	?	?	?	1	1	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	1	?	0	0	0	?	0	1	1
1	0	2	0	?	3	2	1	0	2	0
0	1	1	0	0	?	?	?	1	?	?
?	?	0	?	0	1	1	0	0	0	0
0	1	4	?	0	0	0	?	0	?	?
0	?	?	0	?	?	?	0	0	1	0
0	?	?	?	?	?	0	?	0	1	0
0	1	0	0	0	0	1	1	0	0	0
0	0	0	0	0	1	1	0	0	?	?
0	-	?	0	0	0	4	0	0	0	0
0	?	?	0	0	1	0	0	?	?	?
0	?	?	?	?	0	0	?	0	0	?
0	-	0	0	0	0	-	?	?	?	?
0	0	0	1	2	?	1	?	?	0	2
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1	0	0	1	?	0	0	2	1	0	0
0	0	0	0	0	0	?	?	?	?	?
0	0	1	2	2	1	1	1	1	0	0
?	1	0	0	0	?	2	2	1	0	1
1	0	-	0	1	1	0	0	0	0	2
0	0	1	?	?	0	0	0	?	?	1
-	-	-	-	-						
Teleosaurus_cadomensis			1	5	0	0	?	2	1	0
0	1	3	0	0	2	0	0	?	?	?
0	2	0	?	?	?	?	0	0	-	?
0	1	0	0	1	0	?	?	?	0	?
?	?	?	1	1	?	0	0	1	2	1
2	1	-	0	0	0	?	0	1	0	0
0	0	0	0	0	0	0	0	1	0	0
0	1	0	0	0	0	0	0	0	0	1
1	0	0	0	0	?	0	1	0	1	1
0	0	0	0	-	0	0	-	0	0	0
-	0	0	0	0	0	0	0	0	0	0
1	0	0	1	0	0	0	1	1	0	0
0	-	1	2	0	0	0	?	0	2	1
0	1	0	0	0	1	0	0	1	0	-
-	0	0	?	?	0	3	0	1	0	0
0	0	1	?	0	0	?	?	2	1	2

1	?	?	?	0	0	0	0	2	0	0
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?	0	0	0	1	0	0	0	0	?	0
1	0	?	?	?	1	1	0	2	0	0
?	1	1	1	0	0	0	?	0	1	?
?	0	2	0	?	3	2	?	0	?	0
?	?	?	?	?	1	?	?	?	?	?
0	?	0	1	0	1	?	0	0	0	0
0	1	4	1	?	?	0	?	0	?	?
0	?	?	?	?	?	?	?	?	?	?
?	1	0	?	?	?	0	?	0	1	?
0	?	?	?	?	0	1	1	0	0	0
0	?	0	0	0	1	?	?	?	?	?
?	?	?	?	?	0	?	?	0	0	0
0	?	?	0	?	?	0	?	?	?	?
0	?	?	?	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	0	?	?
0	0	?	?	?	?	1	?	?	?	2
1	?	?	?	?	0	0	0	?	?	0
?	?	?	?	?	?	?	2	1	0	0
0	0	0	0	0	?	?	?	?	?	?
0	?	?	?	?	?	1	1	?	?	?
?	?	?	?	?	?	?	?	1	0	1
1	0	-	0	1	1	0	0	0	0	2
0	0	1	?	?	0	0	0	?	?	?
-	-	-	-	-						
Mycterosuchus_nasutus	1	3	1	0	0	2	1	0	0	
1	3	0	0	2	0	0	?	?	?	?
2	?	?	0	1	1	0	0	-	0	0
1	0	0	1	0	1	0	2	0	0	0
0	1	0	1	0	0	0	1	2	1	2
1	-	0	0	0	1	0	1	0	0	0
0	0	0	0	?	0	?	?	0	0	0
1	0	0	0	0	0	0	0	0	1	1
0	0	0	0	?	0	1	0	0	1	0
0	0	0	-	0	0	-	0	0	0	-
0	0	0	?	0	0	0	0	0	0	1
1	0	0	0	0	0	1	1	?	0	0
-	1	2	0	0	0	?	?	2	1	0
1	0	0	0	1	0	0	1	0	-	-
0	0	?	?	?	3	0	1	0	?	?
?	1	?	0	?	?	0	2	1	2	?
1	0	0	0	?	0	?	2	?	?	1
0	?	?	1	?	?	1	1	1	0	?
?	?	?	?	?	?	1	1	0	0	?
0	?	?	?	?	?	?	0	1	0	1
0	0	0	0	?	?	?	?	0	0	?
1	?	?	0	0	0	0	0	1	1	1
0	2	0	3	[23]	2	1	?	?	0	0
?	?	?	?	1	?	0	?	?	?	0
?	?	?	0	1	2	0	0	0	0	0

2 4 1 1 1 0 0 0 0 0 0
0 0 0 2 0 0 0 0 1 0 0
1 0 0 0 ? ? 1 ? ? ? 0
1 0 0 0 0 1 1 0 0 0 0
0 0 0 ? 1 1 0 0 0 ? ?
? ? 0 ? 0 4 0 0 0 0 0
0 ? ? 0 1 0 ? ? ? ? 0
0 0 ? ? 0 0 0 ? 0 0 0
- 0 0 0 0 - ? ? ? 1 ?
? ? 1 2 ? 1 2 0 0 2 1
0 0 0 0 0 0 0 0 1 0 ?
? ? ? ? ? ? 2 1 ? ? ?
? ? ? ? ? ? ? ? ? ? 0
0 1 3 3 1 1 1 1 0 0 ?
1 0 ? ? ? ? ? 1 1 1 ?
? ? 0 1 0 0 0 0 0 2 0
? 1 ? ? ? ? 0 ? ? ? -
- - - -

Bathysuchus_megarhinus 1 ? ? 0 0 2 1 0
0 1 0 3 1 0 0 ? ? ? ?
? ? ? ? 0 1 1 0 0 - 0
0 1 0 0 1 0 1 0 2 0 0
0 2 1 0 1 0 0 0 1 2 1
2 1 - 0 ? ? ? ? ? 0 0
? ? ? 0 ? ? ? ? ? 0 0
? ? ? ? ? ? ? ? ? ? ?
? ? 0 0 0 ? 0 1 0 0 0
0 0 0 0 - 0 0 - 0 ? 0
- ? ? ? ? 0 0 ? ? 0 0
1 0 0 ? ? 0 0 1 1 ? 0
? ? 1 2 0 0 0 ? 0 2 1
? ? 0 ? 0 ? ? ? ? ? -
- ? ? ? ? ? 3 ? 1 0 ?
? ? ? ? 0 ? 1 0 ? ? ?
? ? ? 0 0 0 0 ? ? ? ?
? ? ? ? ? ? ? 1 1 1 0
1 0 0 0 ? ? 0 ? ? 0 0
? 0 ? ? ? ? ? ? ? ? ?
0 ? ? 0 0 ? ? ? ? 0 ?
? ? ? ? ? ? ? ? ? ? ?
? 0 2 0 3 3 ? ? ? ? 0
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? 0 ?
0 1 4 ? 1 1 0 0 0 0 0
0 0 0 ? 1 0 0 0 0 1 0
0 1 0 0 ? 1 0 0 0 ? ?
0 1 0 0 0 0 ? 1 0 0 0
0 0 ? 0 ? 1 1 0 0 0 ?
? ? ? ? ? 0 4 0 ? ? ?
0 ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?

?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	1	1	?
?	?	?	?	?	?	?	?	?	?	?
?	0	?	?	?	?	?	?	?	?	?
-	-	-	-	-						
Steneosaurus_bollensis	1	0	0	0	[01]	2	1	0	0	
0	3	0	0	2	0	0	1	1	?	0
2	?	2	0	1	1	0	0	-	0	1
1	0	0	1	0	1	0	2	0	0	0
0	0	1	1	0	0	0	1	2	1	2
1	-	0	0	0	1	0	1	0	0	0
0	0	0	0	0	0	0	1	0	0	0
1	0	0	0	0	0	0	0	0	1	1
0	0	0	0	?	0	1	0	0	0	0
0	0	0	-	0	0	-	0	0	0	-
0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	1	1	0	0	0
-	1	2	0	0	0	?	0	2	1	1
0	0	0	0	1	0	0	0	0	-	-
0	0	0	0	0	3	0	1	0	0	0
0	1	?	0	0	1	0	2	1	?	?
1	0	?	0	0	0	0	2	?	0	1
0	1	1	1	0	1	1	1	1	0	1
0	0	0	0	0	0	1	1	0	0	?
0	0	0	1	0	1	0	0	1	0	1
0	0	0	0	1	?	0	?	0	0	0
1	1	1	0	0	0	0	0	1	1	1
0	2	0	3	3	2	1	0	2	0	0
1	1	0	0	1	1	0	1	1	1	0
?	0	1	0	1	1	0	0	0	0	0
2	4	1	0	0	0	0	0	0	0	1
0	0	0	1	0	0	0	0	1	0	0
1	0	0	0	0	0	1	0	1	0	0
1	0	0	0	0	1	1	0	0	0	0
0	0	0	0	1	1	0	0	?	?	0
-	?	0	0	0	4	0	0	0	0	0
0	?	0	0	1	0	0	?	1	0	0
0	0	?	?	0	0	0	0	0	?	0
-	0	0	0	0	-	0	0	?	1	0
0	0	1	2	?	1	0	0	0	2	2
0	0	0	0	0	0	0	0	0	0	1
0	0	1	1	0	0	2	1	0	0	0
0	0	0	0	0	0	0	0	1	0	0
0	1	2	2	1	1	1	1	0	0	?
1	0	0	0	0	2	2	1	1	1	1
0	-	0	1	0	0	0	0	0	2	0
0	1	?	0	0	0	?	0	0	1	-
-	-	-	-							

Steneosaurus_leedsi		1	3	1	0	0	2	1	0	0
0	3	0	0	2	0	0	?	?	?	?
2	?	?	0	1	1	0	0	-	0	1
1	0	0	1	0	1	0	2	0	0	0
0	0	1	1	0	0	0	1	2	1	2
1	-	0	0	0	1	0	1	0	0	0
0	0	0	0	0	0	0	1	0	0	0
1	0	0	0	0	0	0	0	0	1	1
0	0	0	0	?	0	1	0	0	0	1
0	0	0	-	0	[01]	-	0	0	0	-
0	0	0	0	0	0	0	0	0	0	1
2	0	0	0	0	0	1	1	0	0	0
-	1	2	0	0	0	?	?	2	1	1
0	0	0	0	1	0	0	0	0	-	-
0	0	0	0	0	3	0	1	0	0	0
0	1	?	0	0	1	0	2	1	2	1
1	0	0	0	0	0	0	2	0	0	1
0	1	1	1	0	1	1	1	1	0	1
0	0	0	?	0	?	1	1	0	0	?
0	?	0	1	0	1	0	0	1	0	1
0	0	0	0	1	?	0	?	0	0	0
1	1	?	0	0	0	0	0	1	1	1
0	2	0	3	[23]	2	1	0	2	0	?
1	1	0	0	1	1	0	1	1	?	0
?	0	1	0	1	1	0	0	0	0	0
2	4	1	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	1	0	0
1	0	0	0	0	0	1	0	1	?	0
1	0	0	0	0	1	1	0	0	0	0
0	0	0	0	1	?	?	0	?	?	?
?	?	0	0	0	4	0	0	0	0	0
0	1	0	0	1	0	0	1	1	0	0
0	0	0	1	0	0	0	0	0	0	0
-	0	0	0	0	-	0	0	?	1	0
0	?	1	2	0	1	0	0	0	2	2
0	0	0	0	0	0	0	0	1	0	?
0	?	?	1	0	0	2	1	0	0	0
0	0	1	0	0	0	0	0	1	0	0
0	1	4	3	1	1	1	1	0	0	1
1	0	?	0	0	?	?	1	1	1	1
0	-	0	1	0	0	0	0	0	2	0
0	1	?	0	?	0	?	?	0	?	-
-	-	-	-							
Aeolodon_priscus		?	?	?	?	0	2	1	0	0
1	0	1	1	?	?	?	?	?	?	?
?	?	?	?	?	?	?	0	-	0	?
1	0	0	?	0	?	0	2	0	0	?
?	?	0	1	?	0	0	1	2	?	?
1	-	0	0	0	?	?	1	?	0	?
0	0	0	0	?	?	?	?	?	0	?
?	0	?	?	0	?	?	?	?	?	?
?	0	?	?	?	0	?	0	0	1	0

0	0	0	-	0	?	-	0	0	0	-
?	0	?	?	0	0	0	0	0	0	1
0	0	?	?	0	0	1	1	?	0	?
?	?	?	0	0	?	?	?	?	1	1
1	0	?	?	?	?	?	?	?	-	-
0	?	?	?	?	3	0	1	0	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	0	0	0	?	?	?	?	?
0	2	0	3	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	0	?	?
2	4	1	1	1	0	?	?	?	?	0
?	?	0	?	?	?	?	?	?	?	?
?	0	0	0	0	0	?	?	?	?	0
?	?	?	?	0	?	?	0	0	0	0
0	?	0	0	1	?	0	?	?	?	?
?	?	?	?	0	4	0	0	0	0	0
?	?	?	0	?	0	?	?	1	?	0
?	?	?	?	?	0	?	0	0	?	0
-	?	?	?	?	-	?	?	?	?	?
?	?	?	?	?	?	?	?	?	2	2
?	?	?	?	0	0	0	0	1	0	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	1	4	4	1	1	?	?	?	?	?
?	?	?	?	?	2	?	1	1	1	?
0	-	0	1	?	0	0	0	0	?	?
?	1	?	?	?	?	0	?	0	?	-
-	-	-	-							
Steneosaurus_heberti		1	3	1	0	1	2	1	0	0
0	3	0	0	2	0	0	?	?	?	?
2	?	2	0	1	1	0	0	-	0	1
1	0	0	1	0	1	0	2	0	0	0
0	0	?	1	0	0	0	1	2	1	2
1	-	0	0	0	0	0	1	0	0	0
0	0	0	0	0	?	0	1	?	0	?
0	0	-	-	-	0	0	-	-	-	-
0	0	0	0	?	0	1	0	0	0	1
0	0	0	-	0	0	-	0	?	0	-
0	?	?	?	0	0	0	0	0	0	1
1	0	0	?	?	?	1	?	0	0	0
-	1	2	0	0	0	1	0	2	1	1
0	0	0	0	1	0	0	0	0	-	-
?	?	?	0	?	3	0	1	0	0	?
0	1	?	0	?	1	0	2	1	?	?
?	0	?	?	?	?	?	?	0	?	1
0	1	1	1	?	1	2	1	1	0	1

0	0	0	0	?	?	1	1	0	0	?
0	?	?	?	0	1	0	?	1	0	?
?	0	0	0	?	?	0	?	0	0	?
1	1	1	0	0	0	0	0	1	1	1
0	2	0	2	?	2	1	0	2	0	0
?	?	?	0	1	1	0	1	1	?	0
?	0	0	0	1	1	0	0	0	0	0
2	4	1	0	0	0	0	0	0	?	0
0	0	0	?	0	0	0	0	1	0	0
1	0	0	?	1	0	1	?	0	0	0
?	0	0	0	0	1	1	0	0	0	0
0	0	0	0	[12]	1	0	0	?	?	?
?	?	0	0	0	4	0	0	0	0	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	-	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	-
-	-	-	-							
Deslongchampsina_larteti			1	?	?	?	1	2	1	0
0	0	3	0	0	2	0	0	?	?	?
?	2	?	?	0	1	1	0	0	-	0
1	1	0	0	1	0	1	0	2	0	0
0	0	0	?	1	0	?	0	1	2	1
2	1	-	0	0	0	1	0	1	0	0
0	?	0	0	?	0	0	0	1	0	0
0	1	0	0	0	0	0	1	0	0	1
1	0	0	?	0	?	0	?	0	?	0
?	?	?	0	-	?	?	-	0	0	0
-	0	0	0	0	0	0	0	0	0	?
1	1	?	0	0	0	0	?	?	?	?
?	?	1	2	0	0	0	?	?	2	1
1	0	0	0	0	1	?	?	0	0	-
-	?	0	?	0	?	3	0	1	0	0
0	0	1	?	?	?	1	0	2	1	2
1	1	?	0	0	0	0	0	2	0	?
?	?	?	?	1	0	1	1	1	1	0
1	?	0	0	?	?	?	?	?	0	0
?	0	?	?	?	?	1	?	?	?	0
1	0	0	0	0	1	?	?	?	0	0
?	1	1	?	?	?	?	0	?	1	?
1	?	?	?	2	?	2	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	?
0	2	4	1	0	0	0	0	0	0	0
?	0	0	?	?	?	?	?	?	?	?

?	?	?	?	?	1	?	?	?	0	0
0	?	?	?	?	0	1	1	0	0	0
0	0	0	0	0	1	1	0	0	0	?
0	-	?	0	0	?	4	0	0	0	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
-	-	-	-	-						
Steneosaurus_edwardsi	1	3	1	0	1	0	1	0	0	
0	3	0	0	2	0	0	?	?	?	?
2	?	?	0	1	1	0	0	-	0	1
1	0	0	1	0	1	0	2	0	0	0
0	0	1	1	0	0	0	1	2	1	2
1	-	0	0	0	1	0	1	0	0	0
0	0	0	0	0	?	0	1	0	0	0
0	0	-	-	-	0	0	-	-	-	-
0	0	0	0	?	0	1	0	0	0	1
0	0	0	-	0	0	-	0	0	0	-
0	0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	1	1	0	1	0
-	1	2	0	0	0	?	0	2	1	1
0	0	0	0	1	0	0	0	0	-	-
0	0	?	0	0	3	0	1	0	0	0
0	1	?	0	?	1	0	2	1	2	1
1	0	[12]	0	?	?	?	2	?	?	1
0	1	1	1	?	?	1	1	1	0	1
0	0	0	0	0	0	1	1	0	0	?
0	?	0	1	0	1	0	0	1	0	1
0	0	0	0	1	?	0	?	0	0	?
1	?	?	0	0	0	0	0	1	1	1
0	2	0	1	3	2	1	0	2	0	0
?	?	?	0	1	?	0	?	?	1	0
?	0	1	0	1	1	0	0	0	0	0
2	3	1	0	0	0	0	0	0	0	1
0	0	0	1	0	0	0	0	1	0	0
1	0	0	0	1	?	1	?	0	0	0
1	0	0	0	0	1	1	0	0	0	0
0	0	0	0	1	1	0	0	?	?	0
-	?	0	0	0	4	0	0	0	0	0
0	1	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0
-	0	0	0	0	-	0	0	?	1	0
?	?	1	2	0	1	0	0	0	2	2
0	0	0	0	0	0	0	0	1	0	?

0 ? ? 1 0 0 2 1 0 0 0
0 0 1 0 0 0 0 0 1 0 0
0 1 4 3 1 1 1 1 0 0 1
1 0 ? ? ? ? ? 1 1 1 1
0 - 0 1 0 0 0 0 0 2 0
? 1 ? ? 0 ? 0 ? ? ? -
- - - -
Yvridiosuchus_boutilieri 1 3 1 0 1 0 1 0 0
0 3 0 0 2 0 0 ? ? ? ?
2 ? ? 1 1 1 0 0 - 0 1
1 0 0 1 0 1 0 2 0 0 ?
0 0 1 1 0 ? 0 1 2 1 2
1 - 0 0 0 1 0 1 0 0 0
0 0 0 0 0 0 ? ? 0 ? ?
1 0 0 0 0 0 0 0 0 1 1
0 0 0 0 ? 0 1 0 5 0 1
0 0 0 - 0 0 - 0 0 0 -
0 0 0 0 0 0 0 0 0 0 1
1 0 0 0 0 0 1 1 0 1 0
- 1 2 0 0 0 ? ? 2 1 [01]
0 0 0 0 1 0 ? 0 0 - -
0 0 ? ? ? 3 0 1 0 0 0
0 1 ? ? ? ? ? ? ? 2 1
? ? ? 0 1 0 0 2 0 ? 1
0 1 1 1 0 1 1 1 1 0 1
0 0 0 0 ? 0 1 1 0 0 ?
0 ? ? 1 0 1 0 0 1 0 1
0 0 0 0 1 ? 0 ? 0 0 ?
1 1 ? ? ? ? 0 0 1 ? 1
0 2 0 ? 3 2 1 [01] 2 0 0
? ? ? ? 1 ? 0 ? ? 1 0
? 0 1 0 1 1 0 0 0 0 0
2 4 1 0 0 0 0 0 0 0 1
0 0 0 1 0 0 0 0 1 0 0
1 0 0 0 1 0 0 0 0 0 1
1 0 0 0 0 1 1 0 0 0 0
0 0 0 0 0 [01] 0 0 2 1 2
1 1 0 0 0 4 1 0 0 0 0
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? -
- - - -
Lemmysuchus_obtusidens 1 3 1 0 1 0 1 0
0 0 3 0 0 2 0 0 ? ? ?

?	2	?	?	1	1	1	0	0	-	0
1	1	0	0	1	0	1	0	2	0	0
0	0	0	1	1	0	?	0	1	2	1
2	1	-	0	0	1	[01]	0	1	?	0
0	0	0	0	0	0	?	0	1	0	0
?	0	0	-	-	-	0	0	-	-	-
-	?	0	0	?	?	0	1	?	5	0
1	0	0	?	-	0	0	-	0	?	0
-	0	?	?	?	0	0	0	0	0	0
1	[01]	0	0	?	?	?	1	1	0	1
?	?	1	2	0	0	0	?	0	2	1
0	0	0	?	?	?	?	0	?	?	-
-	?	?	?	0	?	3	0	1	?	?
?	0	1	?	?	?	1	0	2	1	2
1	1	0	?	?	?	?	?	?	?	?
1	?	1	?	?	?	?	1	1	1	0
?	?	0	0	0	?	0	1	1	0	0
?	0	?	?	1	?	1	?	?	?	0
1	0	0	0	0	?	?	0	?	0	0
?	1	?	?	?	?	0	0	0	1	1
1	0	2	0	1	?	2	?	?	2	0
?	?	?	?	0	1	?	0	?	?	?
0	?	?	?	0	1	1	0	[01]	0	0
0	2	4	1	0	0	0	0	?	?	?
1	0	0	0	1	0	0	0	0	1	0
?	1	0	0	0	1	?	0	?	?	?
1	1	0	0	0	0	1	1	0	0	0
0	0	0	0	0	0	1	0	0	2	1
2	1	1	0	0	0	4	1	0	0	0
0	?	?	?	1	1	0	0	?	2	?
0	0	0	0	?	0	1	0	0	0	?
0	-	?	?	?	?	-	?	?	?	1
?	?	?	?	?	?	1	0	0	?	?
?	?	?	0	?	?	0	0	0	1	0
?	?	?	?	?	?	0	2	1	0	0
0	0	0	1	0	[01]	?	?	0	1	1
0	0	1	?	3	1	1	1	1	0	0
1	1	0	?	?	?	?	?	1	3	1
1	0	-	0	1	0	0	0	0	0	2
0	0	1	?	?	?	0	?	?	1	?
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Machimosaurus_buffetauti			1	3	1	0	1	0	0	0
0	0	3	0	0	2	0	0	?	?	?
?	2	?	?	1	1	1	0	0	0	0
1	1	0	0	1	0	1	0	2	0	0
0	0	0	1	1	0	?	0	1	2	1
2	1	-	0	0	0	1	0	1	0	0
0	0	0	0	0	0	?	?	?	0	0
0	0	0	-	-	-	0	0	-	-	-
-	0	0	0	0	?	0	1	0	5	0
1	0	0	0	-	0	0	-	0	0	0
-	0	0	0	0	0	0	0	0	0	0

1	0	0	0	0	0	0	?	?	0	1
0	-	1	2	0	0	?	?	0	2	1
0	0	0	0	0	1	0	0	?	?	-
-	0	0	?	0	?	3	0	1	0	?
?	0	1	?	0	?	1	0	2	1	2
1	?	0	1	0	?	0	?	2	?	?
1	0	?	?	?	?	1	1	1	?	0
1	0	0	0	0	?	?	1	1	0	0
?	0	?	?	?	?	?	?	?	?	?
1	0	0	0	0	?	?	0	?	0	0
?	1	1	?	0	0	0	0	0	1	1
1	0	2	0	1	?	2	1	0	2	0
0	?	?	?	0	1	?	0	?	?	1
0	0	0	?	0	1	[01]	0	[01]	0	0
0	3	3	1	0	0	-	0	0	0	0
1	0	0	0	1	0	0	0	0	1	0
0	1	0	0	0	1	0	0	0	0	?
1	1	0	0	0	0	1	1	0	0	0
0	0	0	0	0	0	[01]	0	0	2	?
?	?	?	0	0	0	4	1	0	0	0
0	[01]	1	?	?	1	0	?	?	?	?
0	?	0	0	?	?	?	?	?	?	?
0	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	1	3	1
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0	?	?	?	?	?	?	?	?	?	?
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Machimosaurus_mosae	1	?	?	0	2	0	0	0	0	
0	2	0	0	2	0	0	?	?	?	?
?	?	?	1	1	1	?	0	0	0	1
1	0	0	1	0	1	0	2	0	0	0
0	0	?	1	0	?	0	?	2	1	2
1	-	0	0	0	?	?	1	0	?	0
0	0	0	0	0	?	?	?	0	0	?
0	0	-	-	-	0	0	-	-	-	-
0	0	0	0	?	0	1	0	5	0	1
0	0	0	-	0	0	-	0	0	0	-
?	?	?	?	0	0	0	0	0	0	1
0	0	0	?	0	0	?	?	?	1	?
?	1	2	0	0	?	?	?	?	1	0
0	0	0	0	1	0	0	0	0	-	-
0	0	?	?	?	?	0	1	0	?	?
?	1	?	0	?	1	0	2	1	2	1
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0	?	?	?	?	?	0	?	0	0	?
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0	2	0	1	?	2	?	0	?	0	?
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?	?	?	0	1	?	0	0	0	?	0
3	2	1	?	?	-	0	0	?	?	2
0	0	0	?	0	0	0	0	?	0	0
1	0	0	0	1	0	0	0	?	?	1
?	?	?	?	0	1	1	0	0	0	0
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Machimosaurus_hugii	?	?	?	?	?	0	0	0	0	
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?	1	?	?	?	?	?	?	?	2	1
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?	?	?	?	0	1	?	0	0	0	0

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Pelagosaurus_typus 1 2 1 0 0 2 1 0 0
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Magyarosuchus_fitosi ? ? ? ? ? ? ? ? ? ? ?
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0	0	0	0	?	1	0	0	0	0	0
-	0	?	?	?	4	0	?	?	0	0
?	?	?	?	?	?	?	?	?	?	0
?	?	?	?	?	?	1	0	0	?	?
?	1	?	?	?	?	?	?	?	?	?
?	?	2	?	?	?	?	?	?	?	?
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?	?	?	?	0	0	2	1	1	0	0
0	0	?	0	0	?	?	0	?	?	?
0	1	?	2	?	1	2	1	?	0	?
?	?	?	?	?	?	?	1	2	1	1
?	?	?	2	0	0	0	0	0	2	0
0	?	?	?	?	?	?	?	?	?	-
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Teleidosaurus_calvadosii			1	3	1	0	?	0	1	0
0	0	3	0	0	2	?	?	?	?	?
?	2	?	?	?	1	1	0	0	-	0
1	2	0	0	1	0	1	0	2	0	0
?	0	0	1	1	0	0	0	1	2	1
2	1	-	0	0	0	1	0	1	0	0
0	0	0	0	0	0	0	0	0	0	0
0	?	?	?	?	?	?	?	?	?	?
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0	0	0	0	-	0	0	-	0	0	0
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?	?	1	2	0	0	0	?	0	2	2

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-	0	?	?	?	1	3	0	1	1	0
1	0	1	?	0	0	1	0	2	1	2
1	1	0	2	0	0	0	0	2	0	0
?	?	?	1	1	?	?	0	?	?	0
1	0	0	0	0	1	?	1	1	0	0
?	0	?	?	0	0	?	?	0	1	0
1	0	?	0	?	1	?	0	?	0	0
0	?	1	?	0	0	0	0	0	1	1
1	0	0	0	2	2	2	1	0	2	0
0	1	1	0	0	1	1	0	1	1	?
0	0	0	?	0	1	1	0	0	0	0
0	3	2	1	?	?	-	0	0	0	0
2	0	0	0	0	0	0	0	0	?	0
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Peipehsuchus_teleorhinus			?	?	?	?	?	?	1	0
0	?	3	?	?	?	?	?	?	?	?
?	?	?	?	?	1	1	?	?	?	0
1	2	0	0	1	0	1	0	2	0	0
?	0	0	1	1	0	0	0	?	2	1
2	?	-	?	?	?	?	?	?	0	0
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Chile_metriorhynchoid		?	?	?	?	?	?	?	?	?
?	?	0	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	0	0	?	?	?	?	?	?	0	?
?	?	?	?	?	?	?	?	?	?	?
?	0	0	?	?	0	1	?	0	0	0
?	0	1	?	0	0	?	2	0	1	?
0	1	?	?	?	?	?	?	?	0	0
?	0	0	?	0	0	?	?	?	0	?
?	?	?	?	?	?	?	?	?	2	1
?	?	?	?	0	0	0	0	0	?	?
0	?	?	?	?	?	?	?	?	?	?
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0	0	0	?	?	?	?	?	1	0	?
?	?	?	?	?	?	?	?	?	?	?
?	0	0	0	?	0	1	1	0	0	0
0	0	1	-	0	?	-	2	?	?	?
?	?	?	?	?	?	?	?	0	0	0
?	0	0	1	0	0	?	?	?	0	?
?	?	?	?	?	?	?	?	2	?	?
0	0	?	?	0	0	0	0	0	?	?
0	?	?	?	?	3	?	?	?	?	?
?	1	?	?	?	?	?	2	?	?	?
?	?	?	?	?	?	?	?	?	?	0
0	?	1	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	0	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	0	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	2	1
0	0	0	0	0	0	0	?	0	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	1	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	-
-	-	-	-							
Solnhofen_Cricosaurus		?	?	?	?	?	?	?	0	0
?	2	?	?	?	?	?	?	?	?	?
?	?	?	1	1	1	0	0	-	0	1
3	0	-	3	0	1	?	2	0	-	?
0	0	3	1	-	1	0	1	2	1	?
1	-	?	1	?	?	?	1	0	0	0
0	0	0	0	0	1	?	?	1	0	1
0	1	2	0	1	0	0	1	1	1	1
1	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	?	2	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	1	1	?	?	?
?	?	?	?	?	?	?	?	?	3	1
0	0	0	1	0	0	0	0	0	?	?
0	1	0	0	1	3	0	1	1	0	1

0	1	?	2	0	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	0	0	0	1	0	1
0	0	0	1	3	0	-	-	2	0	0
1	1	?	?	?	1	0	1	1	?	0
?	?	?	?	1	?	?	?	?	?	1
3	3	2	?	?	-	0	0	?	?	1
?	?	0	?	?	0	?	?	?	?	?
1	?	?	0	?	0	1	0	1	?	0
0	0	0	1	0	0	0	0	0	0	0
0	0	0	0	1	1	0	0	0	0	0
-	0	0	0	0	0	0	0	0	0	0
?	?	?	2	1	0	2	?	?	0	0
?	?	?	0	0	0	?	0	0	?	0
2	1	1	2	1	1	?	?	?	2	1
0	1	2	2	?	?	0	?	2	2	0
1	1	1	2	1	1	?	?	?	1	0
1	0	?	?	?	?	2	?	0	?	?
?	?	?	?	1	?	?	?	?	2	?
0	0	4	5	1	1	?	?	0	?	2
0	1	2	3	1	2	2	-	-	0	0
-	-	-	-	-	-	0	-	-	-	-
-	-	-	0	1	1	-	-	0	1	-
-	-	-	-							
Cricosaurus_bambergensis			?	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	-	?
?	?	?	?	?	?	?	?	?	?	?
0	0	0	?	?	?	?	?	1	?	1
?	?	?	?	?	?	?	?	?	0	0
0	0	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	3
?	?	?	?	?	?	?	?	?	?	?
?	?	1	0	0	?	?	0	?	?	?
?	?	?	?	?	?	1	0	?	?	2
?	?	1	?	?	?	?	?	2	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	1	0	0	0	0	1	0
1	?	0	0	1	?	0	-	-	2	0
0	1	?	?	0	1	1	0	?	?	?

?	?	?	?	?	?	?	?	?	?	?
1	3	3	1	?	?	-	0	0	0	0
1	0	0	0	?	?	?	?	?	?	?
?	1	?	?	0	?	0	1	0	?	?
0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	1	1	0	0	0	0
0	-	0	0	0	0	0	0	0	0	0
0	?	?	1	2	1	0	2	?	?	0
0	?	?	?	?	?	0	?	0	0	1
0	2	1	1	2	1	0	?	?	?	2
1	0	0	2	2	?	?	?	?	?	?
0	1	1	1	2	?	?	1	?	0	1
0	1	0	?	?	?	0	2	1	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	0	4	5	1	1	?	?	?	?
2	0	1	2	2	1	2	2	-	-	0
0	-	-	-	-	-	-	0	-	-	-
-	-	-	-	0	1	1	-	-	0	1
-	-	-	-	-						
Cricosaurus_elegans		?	?	?	?	?	2	1	0	0
0	2	0	?	0	?	?	?	?	?	?
?	?	?	1	1	1	0	0	-	0	1
3	0	-	3	0	?	?	2	0	-	?
0	0	3	1	-	1	0	1	2	1	2
1	-	0	1	0	1	0	1	0	0	?
0	0	0	0	0	1	1	0	1	0	1
0	1	2	0	1	?	?	?	1	?	?
1	0	0	0	?	0	1	2	0	0	0
0	1	1	-	1	0	-	2	0	1	0
0	1	0	0	0	0	0	0	0	2	0
0	1	1	1	?	0	1	1	?	0	?
?	?	?	?	1	0	?	?	2	3	1
0	0	0	1	0	0	0	0	0	1	0
0	1	0	0	1	3	0	1	1	0	1
0	1	?	2	0	?	?	?	?	?	?
?	0	?	?	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	?	1	?
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	1
0	?	?	0	1	?	?	?	?	0	0
?	?	?	1	0	0	?	0	1	0	1
0	0	0	1	3	0	-	-	2	0	0
1	1	0	?	1	1	?	1	1	?	0
?	1	1	?	1	?	0	1	0	?	1
3	3	2	?	?	-	?	0	?	?	1
?	?	0	?	?	?	?	?	?	?	?
?	?	?	?	?	0	1	0	1	?	0
0	0	0	1	0	0	?	0	?	0	0
0	0	0	0	1	1	0	0	0	0	0
-	0	0	0	0	0	0	0	0	0	0
?	?	?	?	?	?	?	?	?	?	?
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Cricosaurus_suevicus 0 3 1 ? ? 2 1 0 0
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0 1 1 1 ? 0 1 1 ? 0 ?
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0 1 0 0 1 3 0 1 1 0 1
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1 1 1 2 1 0 2 ? ? 0 0
? 1 ? 0 1 0 ? 0 0 1 0
2 1 1 2 1 0 ? 0 ? 2 1
0 1 2 2 ? ? 0 0 2 2 0
1 1 1 2 1 1 1 ? 0 1 0
1 0 1 ? ? ? 2 1 0 - 0
0 1 - - 1 ? ? 1 1 2 0
0 0 4 5 1 1 ? 1 0 0 ?
? 1 2 3 1 ? ? - - 0 0
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Cricosaurus_schroederi 0 3 1 0 ? ? 1 0 0
0 0 3 1 0 0 ? ? ? ? ?
2 ? ? 1 1 1 0 0 - 0 1
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? 0 1 0 1 0 1 ? 0 0
0 0 0 0 0 0 ? 0 1 0 1
0 1 2 0 1 0 0 1 0 1 1
1 0 0 0 ? 0 1 3 ? 0 0
0 1 1 - 1 0 - 2 0 1 0
0 1 0 0 0 0 0 0 0 2 0
0 1 1 1 0 0 1 1 ? 0 ?
? 1 2 0 1 0 1 ? 2 3 1
0 0 0 1 0 0 0 0 0 1 0
0 1 ? ? 1 3 0 1 1 0 ?
0 1 ? 2 0 ? ? ? ? ? ?
? 0 ? ? ? ? ? ? 0 ? ?
? ? ? ? ? ? ? 1 1 1 1
0 ? 0 0 1 ? 1 1 0 0 ?
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? ? ? ? ? 0 - - 2 ? ?
1 1 0 ? ? 1 ? 1 ? ? ?
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0 0 0 0 1 1 0 0 0 0 0
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Cricosaurus_araucanensis 0 3 1 0 ? 2 1 0
0 0 0 3 1 0 0 0 ? 1 1
? 2 ? 2 1 1 1 0 0 - 0
1 3 0 - 3 0 1 ? 2 0 -
0 0 0 3 1 - 1 0 1 2 1
2 1 - 0 1 0 1 1 1 0 0
0 0 0 0 0 0 ? 1 0 1 0

1	0	1	2	0	1	0	0	1	1	1
1	1	0	0	0	?	0	1	2	4	0
0	0	1	1	-	1	0	-	2	0	1
0	0	1	0	0	0	0	0	0	0	2
0	0	1	1	1	0	0	1	1	0	0
?	?	1	2	0	1	0	1	0	2	3
1	0	0	0	1	0	0	0	0	0	1
0	0	?	?	0	?	3	0	1	1	0
1	0	1	1	2	0	1	?	2	?	2
1	?	0	?	1	-	1	0	2	0	0
?	?	?	1	1	0	2	0	1	?	1
1	0	?	0	0	1	0	1	1	0	0
1	0	0	1	?	0	0	0	0	1	0
1	0	0	0	?	1	1	0	2	0	0
?	1	1	?	1	0	0	0	0	1	0
1	0	0	0	?	?	?	?	?	?	0
0	?	?	?	0	?	1	0	1	1	1
0	?	1	1	0	1	?	0	1	0	0
1	3	3	1	?	?	-	0	0	0	0
1	0	0	0	0	0	0	0	0	1	0
0	1	0	0	?	?	0	?	?	1	0
0	0	0	0	1	0	1	1	?	0	0
0	0	0	0	0	?	1	0	0	0	0
0	-	0	0	0	0	0	?	0	0	0
0	?	?	?	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	0	?	?
?	?	?	2	2	?	?	?	?	2	2
0	1	1	1	2	1	1	1	?	0	1
0	1	0	?	1	0	0	2	1	0	-
0	0	1	-	-	1	0	0	1	?	?
0	0	0	4	?	1	1	2	?	0	0
2	0	?	?	?	?	?	?	-	-	0
0	-	-	-	-	-	-	0	-	-	-
-	-	-	-	0	?	?	-	-	0	1
-	-	-	-	-						
Cricosaurus_vignaudi		?	?	?	?	?	2	1	0	0
0	0	3	1	0	?	?	?	?	?	?
?	?	?	?	?	?	?	?	-	?	?
?	?	-	3	0	?	?	?	0	-	?
?	?	3	1	-	?	?	1	?	?	2
1	-	0	1	0	?	0	1	?	0	?
0	0	0	0	0	?	?	0	1	0	?
?	?	?	?	?	?	0	?	?	?	?
?	0	?	0	?	0	1	2	4	0	0
0	1	1	-	1	?	-	2	0	1	0
0	1	0	0	0	0	0	0	0	2	0
0	1	1	1	?	0	1	1	?	0	?
?	?	2	0	1	0	?	?	?	3	?
0	0	0	1	?	?	?	?	?	1	0
0	1	?	?	?	?	?	?	1	0	1
0	?	?	?	0	?	?	?	?	?	?

?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	1	?	?	?	?	0	?
?	?	?	?	?	?	?	?	?	?	?
0	0	0	?	3	0	-	-	2	0	?
?	?	?	?	1	1	?	1	?	?	?
?	?	?	?	?	?	?	?	0	?	1
3	2	?	?	?	-	?	0	?	?	?
?	0	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	1	?	1	?	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	0	?	1	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
1	?	?	?	?	0	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	-	-	?	?
-	-	-	?	?	?	?	?	?	-	-
-	-	-	0	?	?	-	-	?	?	-
-	-	-	-							
Cricosaurus_lithographicus			?	?	?	?	?	2	1	0
0	0	0	3	1	0	?	?	?	?	?
?	?	?	?	?	1	1	?	?	-	0
1	3	0	-	3	0	?	?	2	0	-
?	0	0	3	1	-	1	0	?	2	1
1	1	-	0	1	0	1	0	1	0	0
?	?	?	0	?	?	?	?	?	?	0
?	?	?	?	?	1	?	0	?	?	?
?	?	0	?	?	0	0	1	2	0	0
0	0	?	1	-	1	?	-	2	0	1
0	0	1	0	0	0	0	?	0	0	2
0	?	1	?	1	0	0	1	1	?	?
?	?	1	2	0	1	0	?	?	2	3
?	0	0	?	?	?	?	?	?	?	1
0	0	?	?	?	?	?	?	1	?	?
?	?	?	?	?	?	?	?	2	1	?
?	?	?	?	?	?	?	?	2	?	?
?	?	?	1	?	0	2	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	0	0	?	0
1	0	?	?	?	?	?	?	?	?	0
?	?	?	?	1	0	0	?	0	1	0
1	0	0	0	1	?	0	-	-	2	0
0	1	?	?	0	?	?	?	?	?	1
?	?	?	?	?	1	?	0	1	0	?

1	3	3	1	?	?	-	0	0	?	?
?	?	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	0	1	?	1	?
0	0	0	0	?	?	?	?	0	0	0
0	0	0	0	0	1	1	0	0	0	0
0	?	0	0	0	0	4	0	0	0	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	2
0	1	1	1	2	?	1	?	?	?	1
?	?	?	?	?	?	?	?	?	?	?
?	0	1	-	-	1	?	?	?	?	?
?	0	0	4	5	?	?	?	?	0	?
?	?	?	?	?	?	?	?	-	-	0
0	-	-	-	-	-	-	0	-	-	-
-	-	-	-	0	1	1	-	-	0	?
-	-	-	-	-						
Dakosaurus_lissocephalus			?	?	?	0	?	?	?	?
?	?	?	1	1	0	?	?	?	?	?
?	2	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	0	1	0	1	0	1	?	?
?	?	?	0	?	?	?	1	0	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	0	?	?	?	0	1	2	0	0
0	0	?	1	?	1	?	?	2	0	1
?	0	?	0	0	0	0	?	?	0	1
?	?	1	?	1	0	0	1	1	?	0
?	?	1	2	0	1	0	?	?	2	?
?	0	0	?	1	?	?	?	?	?	1
0	?	?	?	?	?	?	?	1	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	3
1	?	0	0	0	1	?	1	1	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	?
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Cricosaurus_sp_Cuba 1 ? ? ? ? ? ? ? ?
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Rhacheosaurus_gracilis	1	3	1	0	?	2	1	0	0	
0	2	?	?	?	?	?	?	?	?	?
2	?	?	1	?	1	0	0	-	0	1
3	0	-	3	0	?	?	2	0	-	?
?	0	3	1	-	1	0	1	2	1	2
1	-	0	1	0	1	0	1	0	0	?
0	0	0	0	0	?	1	0	1	0	1
0	1	2	0	1	0	0	1	1	1	1
1	0	0	0	?	0	0	2	0	0	0
0	1	1	-	0	0	-	2	0	1	0
0	1	0	0	0	0	0	0	0	?	0
0	1	1	1	0	0	1	1	0	0	?
?	?	2	0	0	0	?	0	2	3	1
0	0	0	1	0	0	0	0	0	1	0
0	1	0	?	1	?	?	1	1	0	1
0	1	?	2	0	?	?	?	?	?	?
?	0	?	?	?	?	0	2	?	0	?
?	?	1	?	0	2	0	?	?	1	1
0	0	0	0	1	?	?	?	?	0	?
?	?	1	?	0	0	0	0	?	0	1
0	?	?	?	1	?	0	?	0	?	?
?	?	1	1	0	0	0	0	1	0	1
0	0	0	?	3	0	-	-	2	0	?
1	1	0	?	1	1	?	1	1	?	0
?	1	?	?	1	1	0	1	0	0	1
3	[23]	?	?	?	-	?	0	?	?	?
?	?	0	?	?	?	?	?	?	?	?
?	?	?	?	?	0	0	0	1	0	0
0	0	0	?	0	1	1	0	?	0	0
0	0	0	0	1	0	-	0	-	-	0
-	0	0	0	0	0	0	0	0	0	0
1	1	1	2	1	0	2	?	?	0	0
?	1	?	?	0	0	?	0	0	1	0
2	1	1	?	?	0	?	0	?	2	1
0	0	?	?	?	?	0	0	?	2	?
1	1	1	2	1	1	1	?	?	1	?
1	?	?	1	0	?	?	?	?	?	?
0	1	-	-	1	?	?	?	?	?	?
0	0	4	5	1	1	?	?	0	0	?
?	1	2	2	1	2	2	-	-	0	0
-	-	-	-	-	-	0	-	-	-	-
-	-	-	0	1	1	-	-	0	?	-
-	-	-	-							
Metriorhynchidae_indet_Cuba		1	?	?	?	?	?	1	0	
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	0	0	0	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	0	0	0	?	0	1	2	0	?

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1	0	?	?	?	?	?	?	?	?	?
?	?	?	?	1	0	0	?	0	1	0
1	0	0	0	?	?	0	-	-	2	0
?	1	1	0	?	?	1	?	1	?	1
?	0	?	?	?	1	?	0	?	0	?
1	3	2	?	?	?	-	0	0	?	?
1	0	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	1	1	0	1	?
0	?	?	?	?	?	1	?	0	0	0
0	0	0	0	0	1	1	0	0	0	0
0	-	0	0	?	?	0	0	0	0	0
0	1	1	?	2	1	0	?	?	?	?
0	?	?	?	?	?	?	?	0	0	?
0	?	?	?	?	?	?	?	0	?	?
?	?	?	?	?	?	?	?	?	?	?
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0	-	-	-	-	-	-	0	-	-	-
-	-	-	-	0	?	?	-	-	0	?
-	-	-	-	-						
Cricosaurus_saltillensis	?	?	?	?	?	0	?	0	0	
0	2	3	1	?	?	?	?	?	?	?
?	?	?	?	?	?	0	?	-	0	1
3	0	-	3	0	?	?	2	0	-	?
0	0	?	1	-	1	0	?	2	1	2
1	-	0	1	0	1	0	1	0	0	?
0	0	0	0	0	?	?	?	?	?	?
0	1	2	0	1	0	0	?	?	?	?
?	0	?	0	?	0	1	3	0	0	0
0	?	1	-	0	?	-	2	?	1	0
0	1	0	0	0	0	0	0	0	2	0
0	?	1	?	?	0	?	1	?	?	?
?	1	2	0	0	?	?	?	?	3	?
0	0	0	1	?	?	?	?	?	0	1
0	?	?	?	?	?	?	1	?	?	?
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	1	0	1
?	?	?	?	1	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	0	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	0	?	?	0	-	-	2	0	0
?	?	?	?	?	1	?	1	1	1	?
?	?	?	?	?	1	?	?	0	?	?
3	2	?	?	?	-	0	0	?	?	2
?	?	0	0	?	0	0	0	?	0	0

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Metriorhynchus_palpebrosus 1 3 1 0 ? 2 1 0
0 0 2 ? ? 1 0 ? ? ? ?
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1 3 0 - 3 0 ? ? 2 0 -
0 0 0 ? 1 - 1 0 1 2 1
2 1 - 0 1 0 1 0 1 0 ?
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Maledictosuchus_riclaensis 1 3 1 ? ? 2 1 0
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Gracilineustes_acutus ? ? ? ? ? 2 1 0 0
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?	?	?	?	?	?	?	?	-	?	1
3	?	0	2	?	?	?	?	0	0	?
0	?	0	1	?	?	?	1	?	?	2
1	-	0	?	0	?	0	?	?	?	?
?	?	0	?	?	?	?	?	1	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	?	?	?	0	1	?	0	0	0
0	0	?	-	0	?	-	2	0	1	0
0	1	0	0	?	?	0	0	0	0	0
0	1	?	?	0	0	?	?	?	1	?
?	?	2	0	0	0	?	?	?	3	1
0	0	0	1	?	?	?	?	?	0	0
0	?	?	?	1	?	?	?	1	?	?
?	?	?	?	0	?	?	?	?	?	?
?	?	?	?	?	?	?	2	?	?	?
?	?	?	?	?	2	?	?	?	?	?
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	0	0	?	?	?	?
?	?	?	?	1	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	0	?	?
3	4	?	?	?	-	0	?	?	?	1
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	?

0	1	0	1	0	0	1	1	0	1	?
?	1	2	0	0	?	?	0	?	3	1
0	0	0	1	0	0	0	0	0	0	0
0	1	0	0	1	3	0	1	1	0	1
0	?	?	1	0	?	?	2	1	2	1
1	0	[01]	1	-	1	0	2	0	0	?
?	?	1	1	0	?	0	1	1	0	1
0	?	0	0	1	?	1	1	0	0	?
0	?	1	?	0	0	0	0	1	0	1
0	0	0	?	1	?	0	?	0	0	?
?	1	?	1	0	0	0	0	1	0	1
0	0	0	1	3	0	-	-	2	0	0
1	1	0	0	1	1	0	0	1	1	0
0	0	1	0	1	1	0	1	0	0	1
3	4	1	?	?	-	0	0	?	?	0
0	1	0	0	1	0	0	0	?	0	0
1	0	0	?	?	0	1	0	1	?	0
0	0	0	1	0	1	1	0	?	0	0
0	0	0	0	1	1	0	0	0	0	0
-	0	0	0	0	4	0	0	0	0	0
1	?	0	2	1	0	?	?	?	?	0
1	1	?	?	0	0	?	0	0	0	0
1	1	1	2	1	0	1	?	?	2	?
?	?	2	2	0	2	0	0	2	?	1
0	0	1	1	1	?	?	?	?	?	?
?	?	?	?	?	?	2	1	0	-	0
0	?	?	?	?	0	0	1	?	?	0
0	0	?	4	1	1	2	1	0	0	2
0	1	2	1	1	2	2	-	-	0	0
-	-	-	-	-	-	0	-	-	-	-
-	-	-	0	1	1	-	-	0	?	-
-	-	-	-							
Metriorhynchus_geoffroyii			?	?	?	?	?	?	1	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	1	1	1	?	0	?	0
1	3	0	0	2	0	1	0	2	0	0
0	0	0	1	1	0	1	0	?	2	1
2	1	-	0	?	?	?	?	?	0	0
?	0	0	0	0	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	0	?	?	2
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	?
?	?	?	?	?	?	?	?	?	?	?

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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	?
1	3	?	?	?	?	-	0	0	0	1
?	0	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
-	-	-	-	-						
Metriorhynchus_superciliosus			1	3	1	0	1	2	1	0
0	0	3	0	0	1	0	0	?	1	1
?	2	0	2	1	1	1	0	0	-	0
1	3	0	0	2	0	1	0	2	0	0
0	0	0	1	1	0	1	0	1	2	1
2	1	-	0	1	0	1	0	1	0	0
0	0	0	0	0	0	?	1	0	1	0
1	0	1	2	0	1	0	0	1	1	1
1	1	0	0	0	?	0	1	1	0	0
0	0	0	1	-	0	0	-	2	0	1
0	0	1	0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	1	1	0	0
0	-	1	2	0	0	0	1	0	2	3
1	0	0	0	1	0	0	0	0	0	0
0	0	1	0	0	1	3	0	1	1	0
1	0	1	?	1	0	1	0	2	1	2
1	1	0	1	1	-	1	0	2	0	0
0	0	?	1	1	0	1	0	1	1	0
1	0	0	0	0	1	0	1	1	0	0
1	0	?	1	0	0	0	?	0	1	0
1	0	0	0	0	1	1	0	?	0	0
0	1	1	1	1	0	0	0	0	1	0
1	0	0	0	1	2	0	-	-	2	0
0	1	1	0	0	1	1	0	0	1	1
0	0	0	1	0	1	1	0	1	0	0
1	3	3	1	?	?	-	0	0	0	1
1	0	0	0	0	0	0	0	0	1	0
0	1	0	0	0	?	0	1	0	1	0
0	0	0	0	1	0	1	1	0	0	0

0	0	0	0	0	1	1	0	0	0	0
0	-	0	0	0	0	4	0	0	0	0
0	1	1	0	2	1	0	2	2	?	0
0	1	1	1	1	0	0	1	0	0	0
0	0	1	1	2	1	0	1	0	?	2
1	1	0	2	2	0	2	0	0	1	?
1	0	0	1	1	1	1	0	0	0	1
?	1	?	?	1	0	0	2	1	0	-
0	0	1	-	-	1	0	0	1	1	1
0	0	0	4	4	1	1	2	1	0	0
2	0	?	2	1	1	2	?	-	-	0
0	-	-	-	-	-	-	0	-	-	-
-	-	-	-	0	1	1	-	-	0	?
-	-	-	-	-						
Geosaurine_indet_Argentina			?	?	?	?	?	?	?	?
?	?	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	0	0	0	?	?	1	?	1	0
0	0	?	?	0	?	?	0	?	?	?
?	?	0	0	?	?	?	?	?	?	?
?	?	0	1	?	?	?	?	2	0	1
0	?	?	?	0	?	?	?	?	?	0
?	0	?	?	?	0	0	?	?	?	0
?	?	?	?	?	?	?	?	?	?	3
?	?	?	0	1	?	?	?	?	?	?
?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	2
?	?	?	?	?	1	?	?	?	0	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
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0	?	?	?	?	?	?	?	?	0	?
1	?	?	?	?	?	?	?	?	?	?
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Metriorhynchus'_casamiquelai ? ? ? 0 1 0 0 0
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Metriorhynchus'_westermanni ? ? ? ? ? ? ? ?
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?	?	0	0	?	?	0	1	2	?	?
?	?	?	1	?	?	1	?	2	?	?
?	?	?	?	?	?	0	?	0	?	0
0	?	1	0	?	?	?	?	?	0	?
?	?	?	?	?	0	?	?	0	?	3
?	0	0	?	?	?	?	?	?	?	?
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?	0	0	?	?	1	?	?	?	0	?
1	?	0	?	?	?	?	?	?	?	?
1	0	?	?	?	?	1	?	2	?	?
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Neptunidraco_ammoniticus			?	?	?	?	?	?	0	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	0	?	?	?	?	?	?	0
?	?	?	0	?	?	?	?	?	1	0
?	?	?	?	?	?	?	?	?	?	?
?	?	0	?	?	?	0	?	2	0	0
0	?	?	?	?	?	?	?	2	?	1
0	0	?	0	0	?	?	?	?	?	1
1	?	?	?	1	0	?	1	?	?	?
?	?	?	?	?	?	?	?	?	?	3

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Metriorhynchus_brachyrhynchus 1 3 1 0 [12] 0 0
0 0 0 3 0 0 1 0 0 ? ?
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0 1 3 0 0 2 0 1 0 2 0
0 0 0 0 1 1 0 1 0 1 2
1 [01] 1 - 0 1 0 1 0 1 0
0 0 0 0 0 0 0 ? 1 0 1
0 0 0 1 2 0 1 0 0 1 1
1 1 1 0 0 0 ? 0 1 1 0
0 0 0 0 1 - 0 0 - 2 1
1 0 0 1 0 0 0 0 0 0 0
1 1 0 1 0 1 0 0 1 1 0
0 ? ? 1 2 0 0 0 1 0 2
3 1 0 0 0 1 0 0 0 0 0
0 0 0 ? 0 0 1 3 0 1 1
0 1 0 1 ? 1 0 1 0 2 1
2 1 1 0 3 0 1 0 0 2 0
0 ? 0 ? 1 1 0 3 0 1 1
2 1 0 0 0 0 1 ? 1 1 0
0 ? 0 ? 1 ? 0 0 0 0 1
0 1 0 0 0 ? 1 1 0 ? 0
0 ? ? 1 1 1 0 0 0 0 1

0	1	0	0	0	1	1	0	-	-	2
0	0	1	1	0	0	1	1	0	0	0
1	0	0	0	1	1	1	1	0	1	0
0	1	3	2	1	?	?	-	0	0	0
0	2	0	0	0	0	0	0	0	0	1
0	0	1	0	0	1	?	0	[12]	0	0
?	0	0	0	0	1	0	1	1	0	0
0	0	0	0	0	0	1	1	0	0	0
1	2	1	1	0	0	0	4	0	0	0
0	0	0	1	0	2	1	0	1	2	?
0	0	1	1	1	1	0	0	1	0	0
0	0	0	1	1	2	1	0	1	0	?
2	1	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	1	0	0	2	1	0
-	0	0	1	-	-	1	0	0	1	1
1	0	0	0	?	3	1	1	2	1	0
0	2	0	?	?	?	?	?	?	-	-
0	0	-	-	-	-	-	-	0	-	-
-	-	-	-	-	0	1	1	-	-	0
?	-	-	-	-	-					
Tyrannoneustes_lythrodectikos			1	3	1	0	?	0	0	0
0	0	3	0	0	1	0	?	?	?	?
?	?	0	?	1	1	1	0	0	-	0
1	3	0	0	2	0	1	?	2	0	0
0	?	0	?	1	1	?	?	1	?	1
1	1	-	0	?	0	1	?	1	0	0
0	0	0	0	0	0	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	0	0	0	?	0	1	1	0	0
0	0	0	1	-	0	?	-	2	0	1
1	0	1	0	0	0	0	0	0	0	1
1	0	1	?	1	0	0	1	1	0	0
?	?	1	2	0	0	0	?	0	2	3
1	0	0	?	1	?	?	?	?	?	0
0	0	?	?	0	?	3	0	1	1	0
?	0	?	?	?	?	1	0	2	1	2
1	1	0	[23]	0	1	0	0	2	0	?
?	?	?	?	?	?	?	0	1	1	2
1	0	?	0	0	1	?	?	?	0	0
?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	1	1	0	?	?	0
?	?	?	?	1	1	0	0	0	1	0
1	0	0	0	1	1	0	-	-	2	0
0	2	1	0	0	?	?	?	?	?	1
0	0	0	1	?	?	1	?	?	0	?
1	3	2	2	?	?	-	?	0	1	0
3	0	0	0	0	0	0	0	0	?	0
0	1	0	0	1	?	1	?	?	?	?
?	0	0	0	1	0	1	1	0	0	0
0	0	0	0	0	1	1	0	0	0	1
2	1	1	0	0	0	2	0	0	0	0

0	?	?	?	?	1	0	1	?	?	?
0	1	1	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	1	?	?	?
?	?	?	2	2	0	?	?	?	?	?
1	0	0	1	1	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	-
0	0	1	-	-	1	1	1	1	1	1
0	0	0	?	?	1	1	2	1	0	0
2	0	?	?	?	?	?	?	-	-	0
0	-	-	-	-	-	-	0	-	-	-
-	-	-	-	0	1	1	-	-	0	?
-	-	-	-	-						
Chouquet_hastifer		?	?	?	?	?	0	0	0	0
0	2	2	?	?	0	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	1
3	0	0	2	0	1	?	?	0	0	?
0	0	2	1	1	1	0	1	?	1	?
1	-	0	1	0	1	0	1	0	0	0
0	0	0	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	?	?	?	0	1	2	0	0	0
0	?	1	-	0	?	-	2	?	1	1
0	1	0	0	0	0	0	0	0	1	1
0	?	?	1	0	0	1	1	?	?	?
?	?	2	0	0	?	?	?	?	3	?
0	0	0	1	?	?	?	?	?	0	0
0	?	?	?	?	?	?	1	?	?	?
?	?	?	?	?	1	1	?	?	2	?
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3	2	2	?	?	-	0	0	1	0	?
1	2	?	?	?	?	?	?	?	?	?
?	?	?	?	?	1	1	0	?	?	0
?	?	?	?	?	?	?	0	0	0	0
0	0	0	0	1	1	0	0	0	?	?
?	?	0	0	?	5	0	0	0	0	0
?	?	?	?	1	0	?	?	?	?	0
?	1	?	?	?	?	?	?	0	?	?
?	1	1	?	?	?	?	?	?	?	?
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Mr_Passmores_specimen ? ? ? 0 ? 0 0 0
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cf_Torvoneustes_(MANCH_J6459) ? ? ? ? ? ? 0
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0	?	0	0	0	0	0	?	?	?	?
?	?	0	1	2	0	1	0	0	1	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	1	0	0	0	0	0	0	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	0
?	?	?	1	?	?	?	?	?	?	?
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Torvoneustes_coryphaeus			1	3	1	0	?	?	?	?
?	0	2	2	1	0	0	?	?	?	?
?	2	?	?	?	?	?	0	0	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	0	1	0	1	?	1	?	?
0	?	?	0	?	0	1	1	0	1	0
0	0	1	2	0	1	0	0	1	0	1
1	1	0	0	0	?	0	1	2	0	0
0	0	1	1	-	0	0	-	2	1	1
1	0	1	0	0	0	0	0	0	0	1
1	0	1	0	1	0	0	1	1	0	1
?	?	1	2	0	0	0	1	0	2	3
1	0	0	0	1	0	0	0	0	0	0
0	0	?	?	0	1	3	0	1	1	0

1	0	1	?	1	0	?	?	?	?	?
?	1	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	0	1	0	2
1	0	0	1	1	1	?	?	?	0	0
1	0	0	1	?	?	?	?	?	?	?
?	?	?	?	0	?	?	0	?	?	?
?	1	1	1	1	1	0	?	?	?	?
?	?	?	?	?	?	0	-	-	2	?
?	2	1	?	?	?	?	0	?	?	1
0	?	?	?	1	1	1	0	1	0	0
1	?	2	2	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	1	0	?	?
1	?	?	?	?	?	?	?	0	0	0
0	0	0	0	0	1	1	0	1	0	?
?	?	?	?	?	?	4	1	?	?	0
0	?	?	?	?	?	?	?	?	?	?
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Torvoneustes_carpenteri			?	?	?	?	?	0	0	0
0	0	2	3	1	0	0	?	?	?	?
?	?	?	?	?	?	?	0	0	?	0
?	3	0	0	2	?	1	0	?	0	0
?	0	?	1	1	1	?	?	1	?	1
1	1	?	0	1	0	1	0	1	0	0
0	0	0	0	0	0	?	?	0	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	0	?	0	?	0	1	2	0	0
0	0	0	?	-	0	?	-	2	?	1
1	0	1	0	0	0	0	0	0	0	1
1	0	1	0	1	?	0	1	1	?	?
?	?	?	?	?	0	?	?	?	?	3
1	0	0	0	1	?	?	?	?	?	0
0	0	?	0	0	?	?	?	1	1	0
?	0	?	?	?	0	1	1	?	?	2
?	1	?	3	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	1	?	?	?	?	0	0
?	?	?	?	?	?	?	?	0	?	0
?	?	?	?	?	?	?	?	?	0	0
?	?	?	?	?	?	?	?	?	?	?
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0	?	?	0	?	?	?	?	?	?	?

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1	3	1	2	?	?	-	0	0	1	0
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?	?	?	?	?	?	1	1	0	0	0
1	?	?	?	?	0	1	1	0	0	0
0	0	0	0	0	1	1	0	1	2	1
3	1	1	0	?	0	4	1	?	0	0
0	?	?	?	2	1	0	1	?	?	?
0	1	1	?	?	?	?	1	0	0	?
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0	0	0	?	?	1	1	2	1	0	0
2	0	?	?	?	?	?	?	-	-	0
0	-	-	-	-	-	-	0	-	-	-
-	-	-	-	0	?	?	-	-	0	?
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Torvoneustes_mexicanus			?	?	?	?	?	?	?	?
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1	?	?	?	?	?	1	?	0	0	0
0	0	0	0	0	1	1	0	1	2	1
3	1	1	?	?	0	4	1	0	0	0
0	?	?	?	?	?	?	?	?	?	?
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Torvoneustes_sp_(SEC_K1707)	?	?	?	?	?	?	?	?	?	?
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Purranisaurus_potens 1 3 1 0 ? ? ? 0 0
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Ieldraan_melkshamensis ? ? ? ? ? ? ? ?
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?	?	?	?	?	?	0	?	[12]	0	?
?	?	?	?	?	?	0	?	2	?	1
1	0	?	?	0	0	0	?	?	0	1
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	0	?	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	1	?	?	?	?	?	?	0	?
?	?	?	?	?	?	?	?	?	?	?
1	0	?	?	?	?	?	?	?	?	?
?	?	?	?	1	1	0	?	0	1	0
1	0	?	?	?	?	0	-	-	2	?
?	2	?	0	?	1	?	?	?	?	1
?	?	?	?	?	?	?	?	?	0	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	0	1	1	0
0	0	0	0	0	1	1	0	0	0	1
2	1	1	0	?	1	1	0	?	?	0
0	?	?	?	?	?	?	?	?	?	?
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Geosaurus_giganteus		?	?	?	?	?	0	?	?	0
?	1	3	?	?	?	0	?	?	?	?
?	?	?	1	1	1	0	0	0	0	?
3	0	0	2	?	?	?	?	?	0	?
?	?	2	1	0	?	?	2	?	?	1
1	-	0	1	0	1	0	1	0	0	0
0	0	0	0	0	?	1	0	1	0	0
0	1	2	0	1	0	0	1	1	1	1
1	0	?	?	?	0	1	2	0	0	0
0	0	?	-	0	0	-	2	?	1	1
0	1	0	0	?	0	0	0	0	1	1
0	?	0	?	0	0	1	?	?	0	?
?	?	?	?	?	?	?	?	?	3	1
0	0	0	1	0	0	0	0	0	0	0
0	1	?	0	1	3	0	1	1	?	?
0	1	?	1	0	?	?	2	?	?	?

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0	?	?	?	?	?	?	?	0	0	?
?	?	?	?	?	?	?	0	?	?	?
?	?	?	?	?	?	?	?	0	?	?
?	?	?	1	1	0	?	0	1	0	1
0	0	0	1	1	0	-	-	2	0	0
2	1	0	0	1	1	?	0	0	1	?
?	?	?	?	?	?	?	1	0	?	1
3	1	1	?	?	-	?	0	0	0	3
?	?	0	0	?	0	?	?	?	?	?
?	?	?	2	?	1	2	0	0	1	0
1	0	?	1	0	0	0	1	1	0	0
0	0	0	0	1	1	0	0	0	2	3
1	1	0	0	1	0	0	0	0	0	0
?	?	?	?	?	0	?	?	?	?	0
?	1	?	?	?	?	?	?	?	?	?
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Geosaurus_grandis		?	3	1	0	?	0	0	0	0
0	1	3	1	?	0	?	?	?	?	?
?	?	?	1	1	1	0	0	0	0	1
3	0	0	2	0	?	0	2	?	0	?
0	0	2	1	0	?	0	1	2	?	1
1	-	0	1	0	1	0	1	0	?	0
0	0	0	0	0	?	?	0	1	0	?
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?	0	?	?	?	0	1	2	0	0	0
0	0	?	-	0	0	-	2	?	1	1
0	1	0	0	0	0	0	0	0	1	1
0	?	0	?	0	0	1	?	?	0	?
?	1	2	0	0	0	?	?	2	3	?
0	0	0	1	?	?	?	?	?	0	0
0	?	?	?	?	?	?	1	1	?	?
0	1	?	?	0	?	?	2	?	?	?
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0	?	?	?	?	?	1	1	0	0	?
?	?	?	?	?	?	?	0	1	?	?
?	?	?	?	?	?	?	?	0	0	?
?	?	?	1	1	0	0	0	1	0	1
0	0	0	?	?	?	?	?	?	0	0
?	?	?	?	?	1	?	0	?	1	?
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3	?	?	?	?	-	0	0	?	?	?
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?	?	?	?	?	1	2	0	?	?	0
0	0	0	?	0	0	0	1	1	0	0
0	0	0	0	1	1	0	0	0	2	3
1	1	0	0	1	0	0	0	0	0	0
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Geosaurus_lapparenti		?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	2	1	1	1
0	1	?	?	?	0	?	?	?	1	1
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0	0	0	0	1	1	0	0	0	2	3
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0 0 ? 2 - 0 ? - ? ? 1
? ? ? ? ? 0 0 0 0 0 1
? ? ? ? ? ? ? ? ? 0 0
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0 0 0 0 0 1 1 1 0 0 1
2 0 1 ? 0 ? 3 0 ? 0 0
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- - - - 0 ? ? - - ? ?
- - - - -

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0	0	0	0	1	1	1	0	0	2	3
0	1	0	0	?	3	0	0	0	0	0
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?	?	?	?	?	?	?	-	-	?	?
?	?	-	-	-	-	?	?	?	-	-
-	-	-	0	?	?	-	-	?	?	-
-	-	-	-							
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-	-	-	-	-						
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?	?	?	?	?	?	?	?	?	2	1

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0	?	?	?	?	0	?	?	?	2	1
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?	?	?	?	?	?	?	?	1	1	?
0	0	?	?	?	1	2	?	0	0	?
?	?	?	?	?	?	?	-	-	0	0
?	?	?	-	-	-	0	-	-	-	-
-	-	?	0	1	1	?	?	?	?	-
-	-	-	-							
Mr_Leeds_dakosaur		1	3	1	0	?	0	0	1	0
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    /1-[456        /1-[457    /1-[458        /1-[459    /1-[460        /1-[461
    /1-[462        /1-[463;

;

proc/;
```

APPENDIX S2.1 - Short Character List

Skull Geometry

1. Skull height, posterior view: skull higher than wide/subequal (0); skull wider than high (1)

2. Position of tooth row, quadrate articular facet and occipital condyle: tooth row and quadrate aligned, at lower level than occipital condyle (0); tooth row lower than quadrate, quadrate aligned with occipital condyle (1); all aligned on same plane (2); tooth row and quadrate below occipital condyle, unaligned, quadrate at lower level (4); tooth row and quadrate below occipital condyle, unaligned, tooth row at lower level (5)

3. Position of tooth row and occipital condyle: unaligned, tooth row lower (0); aligned (1)

4. Position of quadrate condyle and occipital condyle: unaligned, quadrate condyle lower (0); aligned (1)

5. Skull width to length:

6. Snout elongation: nasals and maxillae not elongated (0); nasals and maxillae elongated (1); maxillae elongated but nasals not (2)

7. Rostrum, height and length: wider than high (0); height and width subequal (1); wider than high (2)

8. Rostrum, dorsal view, amblygnathy: no (0); yes (1)

9. Rostrum, flattening of cranial dorsal surface and symphyseal dentary ventral surface: no (0); yes (1)

10. Rostrum, dorsal view, narrowing immediately in front of orbits: no (0); yes (1)

Ornamentation

11. Maxilla ornamentation, dorsal view: no ornamentation, or irregular ridges/grooves (0); noticeable circular-polygonally pitted pattern (1); noticeable groove-ridges pattern (2); noticeable pits and grooves (3)

12. Prefrontal ornamentation, dorsal view: yes (0); no (1)

13. Lachrymal ornamentation, dorsal view: yes (0); no (1)

14. Frontal ornamentation, dorsal view: yes, shallow/deep elliptical pits and shallow/deep grooves (0); yes, shallow/deep elliptical pits (1); yes, shallow/deep grooves (2); no (3)

15. Extension of frontal ornamentation: extends from centre to lateral- and anterior-most areas (0); restricted to centre (1)

16. Intertemporal bar ornamentation, dorsal view: ornamented (0); unornamented (1)

17. Parietal ornamentation, dorsal view: none (0); slight ornamentation (1); strongly ornamented (2)

18. Ridges on palatal surface of maxilla: palatal surface smooth (0); palatal surface ornamented with ridges (1)

19. Presence of sculpturing on the palatal surface of the pterygoid: surface smooth (0); surface sculptured (1)

Internal neuroanatomy, sensory systems and cranial exocrine glands

20. Presence of enlarged blood vessels extending into/from pituitary gland: absent (0); present (1)

21. Presence of enlarged dural venous sinus system: absent (0); present (1)

22. Presence of enlarged internal cephalic exocrine glands: absent (0); present (1)

Pneumaticity (craniomandibular)

23. Internal presence of the "mastoid antrum" in the supraoccipital: absent (0); present (1)

24. Openings on the dorsal surface at the quadrate proximal end: multiple (0); single (1); lacking (2)

25. Presence of foramina aërum (quadrate and articular): absent (0); present (1)

26. Relation of median pharyngeal and pharyngotympanic tubes to basioccipital and basisphenoid: not enclosed by bone (0); partially enclosed (1); entirely enclosed (2)

Neurovascular foramina, rostrum

27. Presence of neurovascular foramina on the dorsal rostrum and ventral-lateral mandible: absent, limited to a single line (0); present in premaxillae, maxillae, dentaries' (1)

28. Premaxillary neurovascular foramina, distance to alveolar margin: close to teeth (0); distant to teeth (1)

29. Anterior maxillary neurovascular foramina, distance to alveolar margin: close to teeth (0); distant to teeth (1)

30. Mid-maxillary neurovascular foramina, form strongly arched line: absent, follows outline of margin (0); present, arched line (1)

31. Posterior maxillary neurovascular foramina, alveolar margin distribution: close or next to alveoli (0); distant to alveoli (1)

32. Distribution of dentary neurovascular foramina relative to alveolar margin, non-tubular snouted forms: foramina form a simple straight line (0); foramina form a sinusoidal line (1)

Cranial rostrum

33. Perinarial crests, presence and morphology: absent, surface even or perinarial fossa (0); present as well defined and distinct ridges (1)

34. External nares orientation: anteriorly/anterodorsally/anterolaterally (0); dorsally/dorsolaterally (1)

35. External nares shape, dorsal view: subcircular (0); oval (1) 'D-shaped' (2); spoon-shaped elongate (3); pear-shaped (4); external nares not exposed (5)

36. External nares shape, anterior view: subcircular or 'B-shaped' (0); '8-shaped' (1)

37. Medical tubercles, external nares: absent (0); dorsal (1); ventral (2)

38. External nares, thickness of anterior margin: less than half anteroposterior length (0); greater than half anteroposterior length (1)

39. External nares, posterodorsal retraction in relation to tooth row: tip of snout, posterior margin does not exceed first premaxillary alveolus (0); tip of snout, posterior margin

exceeds last premaxillary alveolus (1); posterodorsally displaced, posterior margin exceeds beginning of first maxillary alveolus (2)

40. Presence and morphology of perinarial crests: absent or even surface (0); present and well defined (1)

41. Intranarial fossa present at lateral walls of narial cavity: absent (0); present (1)

42. Premaxilla, dorsal/anterodorsal projection of anterodorsal margin: absent (0); present (1)

43. Premaxilla, dorsal view, anteroposterior length relative to rostrum length: less than 25% (0); approximately 25% or more (1)

44. Premaxilla, lateral expansion anterior to premaxilla-maxilla suture: absent (0); present (1)

45. Premaxilla, length compared to width: slightly longer than wide (0); approximately three times or more longer than wide (1)

46. Premaxilla, ventral surface, presence of large depressions or notches: absent (0); present posterior to P1 and/or P2 alveoli (1); present between P1-P2 and P3-P4 alveoli (2)

47. Premaxilla in lateral view: anterior and anterolateral margins are not sub-vertical, and do not extend ventrally (0); anterior and anterolateral margins are slightly sub-vertical, and slightly extend ventrally (1); anterior and anterolateral margins are fully sub-vertical and extend ventrally (2)

48. Premaxilla, lateral view: anterior and anterolateral margins are not subvertical and/or do not extend ventrally (0); anterior and anterolateral margins oriented anteroventrally and extend ventrally (1)

49. Premaxilla, percentage of total length posterior to external nares: greater than 67% (0); between 50-65% (1); between 36-45% (2); 28% or less (3)

50. Premaxilla, posterodorsal process termination: anterior to or at posterior end of external nares (0); posterior to posterior end of external nares (1)

51. Premaxilla, posterodorsal process: short, terminates level to fourth maxillary alveolus or more anteriorly (0); long, terminates level to end of fourth maxillary alveolus or posteriorly (1)

52. Premaxilla, premaxillary septum development: no septum (0); external nares divided by midline premaxillary septum (1)

53. Rostrum, external surface of premaxilla and maxilla: continuous surface (0); distinct ventral and dorsal surfaces (1)

54. Rostrum, constriction at premaxilla-maxilla suture: narrow slit (0); wide cavity, or not constricted (1); well-defined notch (2)

55. Premaxilla, anterior to nares: anterior rami of premaxillae do not meet medially (0); anterior rami of premaxillae narrowly meet anterior to naris (1); anterior rami of premaxillae broadly meet anterior to naris (2)

56. Premaxilla, dorsal view, anterior and posterior medial margins form an ‘8’-shape: absent (0); present (1)

57. Premaxilla, contact with maxilla: premaxilla loosely overlies maxilla (0); premaxilla and maxilla suture together (1)

58. Premaxilla, dorsal view, shape of anterior premaxilla-maxilla contact: triangular (none or little interdigitating) (0); subcircular (moderately interdigitating) (1); strongly 'ragged' interdigitating (2)

59. Premaxilla and nasal distance: none, premaxilla and nasal contact (0); small, less than 50% midline length of premaxilla (1); large, over 80% midline length of premaxilla (2)

60. Nasal, contribution to external nares: present (0); absent (1)

61. Nasal, anterior process, anterior margin relative to first maxillary alveolus: posterior (0); anterior (1)

62. Nasal, morphology: triangular, lateral margins confluent anteriorly (0); subcircular or subrectangular (1); triangular, lateral margins diverge anteriorly (2)

63. Nasal, lateroposterior processes: absent (0); present (1)

64. Nasal, extremely elongated posterior processes: absent (0); present (1)

65. Nasals, fusion at maturity: nasals unfused (0); nasals partially or fully fused (1)

66. Nasal, posterior portion at midline: nasals flat or convex and lack 'midline trench' (0); concavity at midline, 'midline trench' present (1)

67. Nasal, dorsal view, contact with prefrontal: irregular (0); smooth with posterolaterally directed concavity (1)

68. Nasal-prefrontal contact: absent (0); present (1)

69. Premaxilla-maxilla, lateral fossa excavating alveolus of last premaxillary tooth: no (0); yes (1)

70. Maxilla, ventrolateral edge: straight (0); single convexity (1); double convexity (2)

71. Maxilla, position of posterior-most: anterior to, or even with, postorbital bar (0); even with anteroposterior id-length of supratemporal fenestra (1); even with, or posterior to, posterior margins of supratemporal fenestra (2)

72. Maxilla-jugal, presence of enlarged foramina and associated fossa: absent (0); present (1)

73. Maxilla, posterior, presence of lateral fossa(e) beside alveolar margin, anterior to jugal and ventral to lachrymal: absent, bony surface convex or flat (0); present (1)

74. Maxilla, anterior border of maxillary depressions: shallow and poorly defined, or absent (0); deep and well defined (1)

75. Maxilla, posterior, presence of lateral fossa(e) crossing maxillojugal suture: absent, bony surface convex or flat (); present (1)

76. Maxilla, aligned set of large foramina extending posteroventrally from antorbital fossa: absent (0); present (1)

77. Maxilla-lachrymal, contact: partially included in antorbital fossa (0); completely included (1)

78. Lachrymal, contact with nasal: nasal contacts dorsal margin of lachrymal (0); nasal contacts anterior margin of lachrymal (1); no contact (2)

79. Nasal-lachrymal, suture length compared to nasal-prefrontal suture: short, approximately 60% of nasal-prefrontal suture (0); both sutures are subequal (± 25%) (1); long, approximately twice the length of the nasal-prefrontal suture (2)

80. Lachrymal, dorsal exposure: present, can be observed in both dorsal and lateral view (0) absent, only visible in lateral view (1)

81. Lachrymal, dorsal surface lateral development: flush with rim or orbit (0); enlarged, extends laterally over orbit (1)

82. Lachrymal, size: large (0); small (1)

83. Antorbital cavity, presence: absent, internalized (0); present, non-internalized (1)

84. Antorbital cavity: absent, internalized (0); present, non-internalized (1)

85. Antorbital cavity, relation between external and internal antorbital fenestrae: external and internal fenestrae are bot distinguishable (0); external fenestra larger than internal fenestra but no more than twice its area (1); external fenestra much larger than internal fenestra, or eternal fenestra present and internal fenestra absent (2)

86. Antorbital cavity, shape: subcircular, subtriangular, or lozenge-shaped (0); anteroposteriorly elongated (1)

87. Antorbital cavity, presence of sulcus anterior to cavity: absent (0); present (1)

88. Antorbital cavity, size (area) of external antorbital fenestra, relative to orbit: small, being much smaller than orbit, or antorbital cavity absent (0); moderately larger, at least half the diameter of orbit (1); large, being nearly as large as orbit (2)

89. Antorbital cavity, size (length) of internal antorbital fenestra, relative to orbit: small, internal fenestra is <25% length of orbit, or internal fenestra is absent (0); medium, internal fenestra approximately 25-50% length of orbit (1); large, internal fenestra >50% length of orbit (2); very large, internal fenestra approximately same size as orbit (3)

90. Antorbital cavity, participation of nasal in antorbital fenestra: absent, nasals excluded by maxilla-lachrymal contact (0); present, nasals broadly reach internal fenestra

91. Antorbital cavity, participation of jugal in external antorbital fenestra: absent, jugal excluded by maxilla-lachrymal contact (0); present, jugal contacts external fenestra (1)

92. Antorbital cavity, position relative to rostrum: closer to orbit than alveolar margin (0); closer to alveolar margin, or approximately equal distance (although cavity still noticeably closer to orbit) (1)

93. Antorbital cavity, position relative to orbit: close to orbit, with lachrymal narrow between orbit and antorbital cavity (0); distant to orbit, with lachrymal wide between orbit and antorbital cavity (1)

94. Prefrontal-lachrymal fossae: absent (0); present (1)

Skull roof

95. Supratemporal skull roof, dorsal surface: surface complex (0); flat skull table formed by flattened and levelled frontal, postorbital, squamosal and parietal (1)

96. Posterior skull table: non-planar (0); planar (1)

97. Cranial table, width relative to ventral portion of skull: nearly as wide (0); narrower (1)

98. Supratemporal skull roof, dorsal curvature and elongation of squamosal prongs, at maturity: short posterolateral process of squamosal (0); significant posterolateral process of squamosal (1)

99. Supratemporal fenestrae, presence: presence as evident fenestra (0); presence variable during ontogeny (1); absent throughout ontogeny (2)

100. Supratemporal fossa, presence of infratemporal flanges: absent anterior to, and anteromedially to, supratemporal fenestra (0); present anterior to, or anteromedially to, supratemporal fenestra (1)

101. Supratemporal fossa, dorsal view, anterior margin: anterior margin terminates posterior to postorbital (0); anterior margin terminates between anterior and posterior points of frontal-postorbital suture (1); anterior margin terminates level to postorbital anterior margin (2); anterior margin projects more anteriorly than postorbital (3)

102. Supratemporal fossae, shape: longitudinal ellipsoid/subrectangular (0); square-shaped to subrectangular (1); transverse triangle-shaped (2); circular to subcircular (3); triangle-shaped (4); parallelogram-shaped (5)

103. Supratemporal fossa/fenestra, anterior margin shape, anterolateral expansion: no anterolateral expansion (0); anterior margin inclined anterolaterally (anterolateral corners of supratemporal fossae noticeably more anterior than anteromedial corners) (1)

104. Supratemporal fenestra, anteroposterior elongation: length less than, or subequal to anterior width (0); length twice as long as anterior width (1)

105. Supratemporal fenestra, anteroposterior elongation: length less than, or subequal to width of middle of fenestra (±25%) (0); length greater than width of fenestra (>125%) (1)

106. Supratemporal fenestra, size relative to orbits: longer in length than orbit (>110%) (0); subequal in length to orbit (1); smaller than orbit (<90%) (2)

107. Supratemporal fenestra, dorsal view, posterior limit: terminates before posterior-most parietal (0); terminates either near posterior-most parietal or exceeds it (not reaching supraoccipital) (1); more posterior than intertemporal bar (2)

108. Supratemporal fossa/fenestra, dorsal view, posterior margin: largely vertical and barely visible (0); posterodorsally inclined, creating a visible posterior fossa (1)

109. Supratemporal arch, dorsal view, medial margin: not convex (0); convex (1)

110. Supratemporal arch, lateral view, dorsal margin: concave (0); straight (1); convex (2)

111. Supratemporal arch, dorsal view, width: thick (0); thin (1)

112. Prefrontal, dorsal surface lateral development: reduced (0); incipient enlargement (1); enlarged (2)

113. Prefrontal, dorsal view, lateral development relative to posterolateral corner of supratemporal fenestra: prefrontal does not expand laterally, on the same plane as posterolateral corner (0); prefrontal expands further laterally than posterolateral corner (1)

114. Prefrontal, dorsal view, shape: quadrilateral (0); teardrop-shaped (1)

115. Prefrontal dorsal view, lateral border: continuous convex curve, approximately 80-90 degree angle from anteroposterior axis of skull (0); continuous convex curve, approximately 60-70 degree angle from anteroposterior axis of skull (1); continuous convex curve, approximately 50 degree angle from anteroposterior axis of skull (2)

116. Prefrontal, dorsal view, dimensions: longer than wide (0); length and wide subequal (1)

117. Prefrontal, anterior to orbits: elongate (0); short and broad (1)

118. Prefrontal, nasal-prefrontal suture with pronounced rectangular 'concavity': absent (0); present (1)

119. Prefrontal, nasal-prefrontal suture has posteriorly directed 'V'-shape: absent (0); present (1)

120. Frontal, dorsal surface along midline: flat (0); incomplete longitudinal ridge (1); longitudinal ridge along entire length of midline (2)

121. Frontal, dorsal surface: convex or flat (0); concave (1)

122. Frontal, anteromedial process length: anteromedial process is approximately level to, or slightly posterior to, prefrontals (0); anteromedial process noticeably posterior to prefrontals (1)

123. Frontal, anteromedial process: acute anterior angle margin, separating left and right nasals along their posterior margin (0); lacks acute anterior angle margin, nasal posterior margin being either transversely straight of slightly concave/convex (1)

124. Frontal, anteromedial process shape and length: anterior projection medially broad and does not extend far past anterior orbital rim (0); anterior projection mediolaterally thin and extends anterior past anterior orbital rim (1)

125. Frontal, dorsal view, anterolateral projections between nasals and prefrontals: absent (0); present (1)

126. Frontal, contribution to intertemporal bar: contributes to anterior part (0); excluded from intertemporal bar (1)

127. Frontal, angle between posteromedial and posterolateral processes: approximately 90-degree angle (0); approximately 60-70 degree angle (1); approximately 45-degree angle (2)

128. Frontal, dorsal view, minimum width between orbits compared to supratemporal fossa: greater than, or equal to, width of one supratemporal fenestra and intertemporal bar (0); subequal to width of one supratemporal fossa (1)

129. Frontal, minimum width between orbits compared to orbits: broader than orbital width (0); subequal to orbital width (1); narrower than orbital width (2)

130. Frontal-parietal, dorsal view, intertemporal bar: frontal and parietal subequal in width (± 5%) (0); frontal width greater than parietal (can be >75%) (1)

131. Frontal-parietal suture: level with intertemporal bar (0); lower than intertemporal bar (1)

132. Frontal-parietal suture, dorsal view: irregular and straight, or gently curved (0); frontal overlaps postorbital, 'V'-shaped (1); strongly interdigitating (2)

133. Postorbital, dorsal view, shape: outer margin convex (0); forms 90-degree angle (1); anterior extension from corner (2)

134. Postorbital, anterolateral extension: small or absent (0); very large (1)

135. Postorbital and squamosal, dorsal view, lengths: squamosal longer (0); postorbital longer (1)

136. Supratemporal arch, participation of postorbital: small, approximately 30% of total bar (0); extensive, approximately ≥50% of total bar (1)

137. Squamosal, posterior margin lateral to post-temporal fenestrae: straight (0); concave (1)

138. Squamosal, projects more posteriorly than occipital condyle: no (0); yes (1)

139. Squamosal, dorsolateral edge, longitudinal groove: absent (0); present (1)

140. Squamosal, dorsolateral edge, longitudinal groove margins: ventral margin projects more laterally than dorsal margin (0); ventral margin directly underneath dorsal margin (1)

141. Parietals, presumed adults: separate (0); fused (1)

142. Parietals, supratemporal fenestrae separated by: broad, flat area (0); mediolaterally thin strip of bone (1); 'sagittal crest' (2); median longitudinal groove (3)

143. Intertemporal bar, modification of 'sagittal crest': not 'sagittal crest' or does not have dryosaurid morphotype (0); derived dryosaurid morphotype (1)

144. Parietal, dorsal view, bifurcation of parietal immediately posterior to intertemporal bar: absent (0); present (1)

145. Parietals, posterodorsal margin: transversely oriented (0); indented anteriorly (1)

146. Parietals, posteroventral edge: extends more than half the width of occiput (0); extends less than half the width of occiput (1)

147. Post-temporal fenestrae, dorsal view, covered by overhanging posterior extension of parietal: absent (0); present (1)

148. Parietal, occipital view: 'W'-shaped (0); concave (1); flat or convex (2)

Orbit and temporal region

149. Orbit, position: fully dorsal (0); mainly dorsal with slight inclination (1); lateral with slight dorsal inclination (2); fully lateral (3)

150. Orbit, shape: circular (0); longitudinal ellipsoid (1); transverse ellipsoid (2)

151. Circumorbital dorsal margin, shape: flush with skull dorsal surface (0); upturned, prominent along orbital medial margin and frontal interorbital margins upturned (1); upturned, frontal lateral process anterior margins also upturned (2)

152. Circumorbital ventral margin, shape: concave or sub-straight (0); prominent notch (1)

153. Orbit, anterodorsal margin and lachrymal: lachrymal excluded (0); lachrymal included (1)

154. Orbit, posterodorsal margin and postorbital: postorbital excluded (0); postorbital included (1)

155. Orbit, anteroventral margin and lachrymal: lachrymal excluded (0); lachrymal included (1)

156. Orbit, anterior margin and jugal anterior process: jugal anterior process does not contribute to anterior orbital margin (0); jugal anterior process, and lachrymal, for anterior orbital margin (1)

157. Orbit, anterior margin and broadening of jugal anterior process: jugal anterior process does not help form anterior orbital margin, or jugal anterior process is narrow (0); jugal anterior process, and lachrymal, form anterior orbital margin but distinctly dorsoventrally broad (1)

158. Orbit, posteroventral margin and postorbital: postorbital excluded, or only present in posteroventral margin (0); postorbital included and extensively forms part of orbit ventral margin (1)

159. Orbit, ventral margin and jugal: jugal participates (0); jugal excluded (1)

160. Supraorbital notch, dorsal view, deeply excavated and resulting in broadly exposed frontal along lateral margin of orbits: absent (0); present (1)

161. Supraorbital notch, dorsal view, very small, being a tight 'U'-shape, by prefrontal expanding posteriorly: absent (0); present (1)

162. Palpebrals, presence and number: absent, or palpebrals deeply fused with prefrontal (0); one large palpebral (1); two large palpebrals (2)

163. Orbits, presence of sclerotic ossicles: absent (0); present (1)

164. Jugal, width of anterior process relative to posterior process: subequal (0); twice as broad (1)

165. Jugal, anterior process sigmoidal with noticeable convexity along dorsal margin: absent (0); present (1)

166. Jugal, extends anteriorly in front of prefrontal: no (0); yes (1)

167. Jugal, anterior process slender, elongate and extends anteriorly: no (0); yes (1)

168. Postorbital bar, inclination: strongly anterodorsally inclined (0); slightly anterodorsally inclined (1); nearly vertical (2); posterodorsally inclined (3)

169. Jugal, well-developed foramen on anterior ramus: no (0); yes (1)

170. Postfrontal: present (0); absent (1)

171. Postorbital bar, dorsal end: broadens dorsally (0); constricted (1)

172. Postorbital bar, presence of vascular opening at lateral edge of bar: absent (0); present (1)

173. Postorbital bar, postorbital-jugal contact: postorbital medial to jugal (0); postorbital lateral to jugal (1)

174. Postorbital bar, structure: dermal bar, not columnal or transversely flattened (0); subdermal bar, columnar and cylindrical or oval-shaped (1); subdermal bar, columnar and transversely flattened (2)

175. Postorbital bar, lateral surface: formed by postorbital and jugal (0); formed by postorbital, with jugal only exposed on medial surface (1)

176. Quadratojugal-postorbital, contact: absent (0); present (1)

177. Infratemporal fenestra, lateral view: longer in length than orbit (>25%) (0); equal/subequal in length than orbit (± 10%) (1)

178. Quadratojugal, spine: absent (0); small or low crest (1); prominent (2)

Palate and perichoanal structures

179. Premaxillae, presence of subelliptic naso-oral fossa: absent (0); present as discrete fossa/foramen, less than half the width of premaxillae (1); large, more than half the width of premaxillae (2)

180. Premaxillae, shape of naso-oral fenestra: subcircular or longer than wide (0); elongate anteroposterior oval-shaped (1)

181. Suborbital fenestrae, presence and size: absent (0); present, much smaller than orbits (1); present, subequal or larger than orbits (2)

182. Suborbital fenestrae, shape of anterior border: rounded, smooth (0); sharp angle, forming a notch, fissure-like (1)

183. Maxilla, palatal processes: do not meet at midline (0); meet at midline (1); meet at midline and expand anteriorly and posteriorly (2)

184. Maxilla, palatal view, shape of anterior maxilla: tapering (0); straightened (1)

185. Maxilla, posterior margin of palatal processes contact with anterior margin of palatine processes: maxilla-palatine contact only along margin medial to alveolar row (0); maxilla posterior palatine margin has extensive contact with palatine anterior palatal margin (1)

186. Palatal canals, presence: absent (0); present (1)

187. Palate longitudinal depressions, presence: absent (0); present (1)

188. Palatine, anterior extent of palatine relative to maxillary tooth row: palatine anterior margin terminates level to 20th maxillary alveoli, or more distal (0); palatine anterior margin terminates level to 15th to 19th maxillary alveoli (1); palatine anterior margin terminates level to 11th to 14th maxillary alveoli (2); palatine anterior margin terminates level to 8th to 10th maxillary alveoli (3); palatine anterior margin terminates level to 5th to 7th maxillary alveoli (4); palatine anterior margin terminates level to 4th maxillary alveoli, or more anterior (5)

189. Palatine, anterior margin has midline anterior process: present (0); absent (1)

190. Palatine, palatal view, midline anterior process shape: anteriorly oriented ‘V’-shape (0) anteriorly oriented ‘U’-shape (1)

191. Palatine, anterior margin has two non-midline anterior processes: absent (0); present (1)

192. Palatine, at suborbital fenestrae, palatine anterior margin curves anterolaterally: absent (0); present (1)

193. Palate, presence of palatal shelves of palatines: absent, narial passage bounded dorsally by pterygoid (0); narial passage partially bounded laterally by palatal shelves (1); narial passage mostly bounded laterally and ventrally by palatal shelves (2)

194. Palatine, presence of posterior extension of choanae: no contact, or contact along anterior margin (0); contact along anterior and medial margins (1)

195. Palatine-pterygoid suture, lateral protrusions by palatine into pterygoid: absent (0); present (1)

196. Ectopterygoid, presence of broad contact with palatine ramus of maxilla: absent, or barely contacts caudal end (0); present (1)

197. Ectopterygoid, distal ramus: laminar, extends as flattened sheet over pterygoid wing (0); robust, extends as rod over most of pterygoid wing (1)

198. Pterygoid flange, palatal view, orientation: horizontal (0); largely horizontal with posterolateral orientation (1); strongly posterior (2)

199. Choanae, participation of pterygoid in choanal border: pterygoid bounds posterior border of choanae (0); pterygoid forms posterior and lateral choanal borders (1); anterolateral rami of pterygoid embrace most of choanae but do not meet medially (2); anterolateral rami of pterygoid completely embrace choanae (3)

200. Pterygoids, fusion posterior to choanae: not fused (0); fused (1)

201. Choanal opening, palatal view: choanal opening oriented posteriorly, enclosed ventrally by palatine and by either pterygoid dorsally or maxilla (0); choana opens into palate through deep midline depression (1)

202. Choana, anterior margin shape: semi-circular or elliptical (0); 'V'-shaped (1); 'U'-shaped (2); 'W'-shaped (3)

Occipital

203. Occipital tuberosities: absent (0); small and reduced (1); large and well-developed (2)

204. Supraoccipital, presence: fused with exoccipital (0); present as separate ossification (1)

205. Exoccipitals, presence of medial contact between elements: do not meet in midline (0); meet in midline (1)

206. Paraoccipital process, occipital view, orientation: horizontal (0); dorsolaterally oriented (1); ventral-edge horizontal, with terminal third sharply inclined dorsally (2); ventrally arched (3)

207. Paraoccipital process, large ventrolateral region: present (0); absent (1)

208. Paraoccipital process, size relative to exoccipital: approximately same size (0); paraoccipital process substantially larger (1)

209. Paraoccipital process, overlap by squamosal: small, squamosal does not extend further posteriorly (0); large, squamosal extends further posteriorly (1)

210. Foramen for cranial nerve XII, position on occiput: above occipital condyle in line with foramen magnum (0); below foramen magnum (1)

211. Foramen for cranial nerve XII, sits in occipital fossae: absent (0); present (1)

212. Foramen for internal carotid artery, external margin of foramen is raised relative to posterior face of basioccipital: no (0); yes (1)

213. Foramen for internal carotid artery, size: similar to cranial nerves IX-XI (0); enlarged (1)

214. Exoccipital, presence of descending flange ventral to subcapsular process: absent (0); present and laterally concave (1)

215. Exoccipital, contact with quadrate: absent or narrow (0); broad contact (1)

216. Exoccipital, presence of ventrolateral contact with ventromedial part of quadrate: absent, quadrate does not contact exoccipital (0); present, exoccipital and quadrate enclose carotid artery and form passage for cranial nerves IX-XI

217. Exoccipital, participation in occipital condyle: slight to moderate (0); large (1)

218. Occipital surface ventral to occipital condyle: slopes anteroventrally (0); sub-parallel or parallel (1)

Braincase, basicranium and suspensorium

219. Trigeminal fossa, development on quadrate and laterosphenoid: developed anteriorly and posteriorly (0); developed mainly posteriorly (1)

220. Laterosphenoids, sutures with parietal: parallel to skull table (0); descends posteriorly relative to skull table (1)

221. Laterosphenoids, fossa for *m. pseudotemporalis superficialis*: presence of *pseudotemporalis* fossa on dorsal surface of laterosphenoid and/or continuing to frontal (0); absence of *pseudotemporalis* fossa on dorsal surface of laterosphenooid or presence of fossa on posteroventral surface (1)

222. Parasphenoid ridges, palatal view: not visible (0); midline ridge along pterygoids (1)

223. Basisphenoid, paired ridges located medially on ventral surface: absent (0); present (1)

224. Basisphenoid, ventral exposure in adults/young individuals: ample surface exposed ventrally, basisphenoid as long as, or longer than, basioccipital (0); well-exposed, basisphenoid smaller than basioccipital (1); reduced surface (2)

225. Basisphenoid, palatal view, exposure anterior to quadrates: basisphenoid terminates approximately level to anterior quadrate (0); basisphenoid cultriform process exposed along palatal surface anterior to quadrates (1)

226. Basisphenoid rostrum: short (0); long anteriorly (1)

227. Basisphenoid, occipital view, exposure ventral to basioccipital at maturity: absent, pterygoid dorsoventrally short (0); present, pterygoid dorsoventrally tall (1)

228. Basisphenoid, development of basipterygoid processes: prominent (0); small or absent (1)

229. Basioccipital, single wide rugosity oriented anteroposteriorly along midline of ventral surface of occipital condyle: absent (0); present (1)

230. Basioccipital, presence of tuberosities: reduced (0); large and pendulous (1)

231. Basioccipital tuberosities, ventral view: oblong-shaped (0); ‘V’-shaped or teardrop-shaped (1)

232. Paired grooves along ventral surface, extending from bas of occipital condyle to basioccipital tuberosities: absent (0); present (1)

233. Basioccipital, ventral part: vertical, visible in occipital view (0); strongly inclined, weakly visible in occipital view (1)

234. Quadrate, prominent crest on dorsal surface of distal quadrate: absent (0); present (1)

235. Quadrate, contact with proötics: does not contact (0); contact (1)

236. Quadrate, articulation of dorsal head contact: squamosal and exoccpiptal/opisthotic/otoccipital (0); proötic and laterosphenoid (1)

237. Quadrate, posterior margin: no sutural contact with paraoccipital process, or simple contact (0); robust sutural contact with paraoccipital process (1)

238. Quadrate, anteroventral process suturing to braincase: contacts pterygoid, little to no contact with neurocranium (0); extensive contact with laterosphenoid, basisphenoid and pterygoid (1); free of bony attachment along anteromedial surface, but contacts pterygoid ventrally (2)

239. Quadrate, distal articular surface separated into two condyles: yes (0); no (1)

240. Quadrate-quadratojugal, quadratojugal contributes to lateral hemicondyle: formed solely by quadrate (0); quadratojugal contribution (1)

241. Fossa for tympanic membrane, anterior extension: limited to squamosal (0); reaches posterior margin of postorbital (1); broadly exposed on postorbital (2); crosses postorbital and reaches orbit (3)

242. Cranioquadrate canal, contact between quadrate and exoccipital: absent (0); lateral contact between quadrate and exoccipital feeble, but do enclose cranioquadrate canal (1); lateral contact between quadrate and exoccipital broad, do enclose cranioquadrate canal (2)

243. Cranioquadrate canal, bones enclosing: quadrate, squamosal and occipital do not enclose (0); squamosal laterally, quadrate ventrally and exoccipital posteriorly/medially/partially ventrally (1); quadrate and squamosal laterally, exoccipital helps enclose dorsally (2)

244. Cranioquadrate canal, presence of squamosal descending process separating cranioquadrate canal from external auditory meatus: absent (0); present (1)

Mandibular geometry

245. Mandible, positioning of dentary tooth row and coronoid process, and development of dorsal curvature of posterior-most mandible: gentle or no curvature (0); straight curvature, raising coronoid process above tooth row (1)

246. Mandible, relative positions of coronoid process, retroarticular process and glenoid fossa: coronoid process level to retroarticular process and glenoid fossa (0); coronoid process ventral to retroarticular process and glenoid fossa (1)

247. Mandibular rami, presence of sharp dorsal inclination: absent (0); present, immediately posterior to mandibular symphysis (1)

248. Mandible, orientation of hemimandibles at medial contact: acute angle, approximately 45 –degrees (0); broad angle, approximately 70-degrees (1)

249. Mandible, dorsal/ventral views, distal rami: mostly straight or poorly curved (0); strongly curved medially (1)

250. Mandible, lateral view, ventral border at angular: straight and mostly horizontal, or poorly curved (0); evidently but gently curved (1); abruptly curved, below glenoid fossa (2)

251. Mandible, lateral view, ventral margin: mandible curved ventrally, maximum curvature at anterior section of angular, or not curved at all (0); mandible curved posteroventrally, maximum curvature at posterior section of angular (1)

252. Mandible, lateral view, dorsal border at dentary-surangular contact: mostly straight (0); gently arched dorsally (1); strongly arched dorsally (2)

Mandible

253. Anterior mandible, dorsal margin of anterior portion compared to dorsal margin of posterior portion: horizontal (0); ventrally deflected (1); dorsally deflected (2)

254. Anterior mandible, dorsal or ventral views: outer margin converges towards tip or parallel (0); spatulate shape, maximum transverse width at D2 alveoli (1) spatulate shape, maximum width at D3-D4 couplet (2); spatulate shape, maximum transverse width at D4 alveoli (3)

255. Anterior mandible, dorsal or ventral view: non-'gladius' or 'trowel'-shaped (0); 'gladius'-shaped (1); 'trowel'-shaped (2)

256. Mandibular symphysis, length: less than 1/3 mandible length (0); less than ½ and more than 1/3 mandible length (1); under ½ mandible length (2); greater than ½ mandible length (3)

257. Mandibular symphysis, depth: deep, ≥9% mandible length (0); moderate, 6.5-8% mandible length (1); narrow, 4.5-6% mandible length (2); very narrow, ≤4% mandible length (3)

258. External mandibular fenestra, presence: absent (0); present as diminutive passage (1); present as evident fenestra (2)

259. External mandibular fenestra, shape: subcircular to poorly elliptic (0); highly elliptic (1); slit-like (2); broad teardrop shape (3); narrow teardrop shape (4); triangle (5)

260. External mandibular fenestra, anterior margin: curved (0); anterodorsal and anteroventral margins poorly arched, wedge-like (1)

261. Surangular foramen, presence: present and small (0); present and large (1); absent (2)

262. Dentary, ventral margin strongly curved: no (0); yes, ventral margin convex (1); yes, ventral margin concave (2)

263. Dentary foramina, lateral and dorsal surfaces of anterior region of dentary: foramina small or variable in size, number is variable (0); foramina numerous and small to medium-sized (1)

264. Surangululodentary groove: absent (0); subtle, shallow groove (1); deeply excavated (2)

265. Surangulodentary groove, relative length on both elements: longer on dentary (0); equal length on dentary and surangular (1)

266. Surangulodentary groove, large foramen present on dentary terminus: absent (0); present (1)

267. Mandibular grooves, lateral view, dentary: surangulodentary and angulodentary grooves either poorly developed, not elongate, converge towards each other (0); surangulodentary and angulodentary grooves parallel and positioned close to one another (1)

268. Splenial, involvement in mandibular symphysis: slight, <10% symphysis length (0); extensive, ≥15% symphysis length (1); not involved (2)

269. Splenials, dorsal view, excavation of Meckelian groove: deep (0); shallow (1)

270. Angular, lateral view, dorsal curvature: gradual (0); sharp and abrupt (1)

271. Angular, lateral view, extension of anterior lateral ramus: short, does not extend beyond orbits (0); long extends anteriorly beyond orbits (1)

272. Angular, lateral view, posterodorsal extension: reaches retroarticular process (0); does not reach retroarticular process (1)

273. Surangular, lateral view, extension of anterior lateral ramus: short does not extend anteriorly beyond orbits (0); long, extends anteriorly beyond orbits (1)

274. Surangular, dorsal margin of mandible: does not extend anteriorly beyond orbits (0); extends anteriorly beyond orbits (1)

275. Surangular, presence of distinct coronoid process: absent (0); present (1)

276. Surangular, presence of extension to retroarticular process: absent, pinched off anterior to tip of retroarticular process (0); present, extends to posterior end of retroarticular process (1)

277. Prearticulars, presence: present (0); absent (1)

278. Coronoids: present, not exposed on external surface (0); present, exposed on external surface (1); absent (2)

279. Coronoid, anterior development along dorsal margin: does not project as far as dentary row, or coronoid absent (0); projects further anteriorly than posterior-most alveoli (1)

280. Articular, glenoid fossa orientation: anterodorsally (0); dorsally (1)

281: Retroarticular process, development: absent or poorly developed (0); present and projecting posterior to glenoid fossa (1)

282. Retroarticular process, length of attachment surface relative to width: short, subequal (0); moderately elongate, longer than wide (1); extremely elongate, more than twice its width (2)

283. Retroarticular process, surface for attachment of adductor muscles: triangular (0); ellipsoid, rectangular or spoon-shaped (1); shovel/paddle-shaped (2)

284. Retroarticular process, width: narrower than glenoid fossa (0); wider than glenoid fossa (1)

285. Retroarticular process, length: long, longer than wide and longer than glenoid fossa width (0); short, wider than long and shorter than glenoid fossa width (1)

286. Retroarticular process, posteromedial wing position: dorsally situated, or at mid-height (0); ventrally situated (1)

Dentition and alveolar morphologies

287. Tooth row, premaxillary alveoli and posterior maxillary alveoli: upper tooth row largely in same plane (0); posterior maxillary alveoli ventral to other alveoli (1)

288. Premaxilla, alveolar count: six or more (0); five (1); four (2); three or less (3)

289. Maxilla, alveolar count: 11 or fewer (0); 12-16 (1); 17-20 (2); 21-28 (3); 29 or more (4)

290. Maxilla, end of alveolar row: maxillary tooth row terminates posterior to posterior margin of orbit, does not exceed beyond anteroposterior mid-length of supratemporal

fenestra (0); maxillary tooth row terminates level to, or posterior to, anterior margin of orbit (1); maxillary tooth row terminates before anterior margin of orbit (2)

291. Maxilla, presence of deep, pronounced reception pits: absent, reception pits shallow throughout or reception pits conspicuous in anterior third of maxilla and gradually disappear (0); present, receptions pits conspicuous throughout anterior and mid-maxilla and disappear towards posterior-most maxilla (1)

292. Premaxilla, P1-P2 form a couplet: no, interalveolar spacing between P1-P2 and P3-P4 relatively similar (0); yes, interalveolar spacing between P1-P2 much thinner relative to P3-P4 (1)

293. Premaxilla, P3-P4 form a couplet: absent (0); present (1)

294. Premaxilla, palatal view, orientation of Pi and P2: P1 and P2 oriented anteriorly (0); P1 oriented anteriorly, P2 oriented slightly medially (1); P1 and P2 oriented laterally (2)

295. Premaxilla, P1 and P2 do not form a couplet but are oriented to anterior margin of premaxilla: no (0); yes (1)

296. Premaxilla, strongly lateral expansion so P3 and P4 aligned on lateral plane of external margin, more so than P2: absent (0); present (1)

297. Premaxilla, first premaxillary alveolus very small and <25% of second premaxillary alveolus: yes (0); no (1)

298. Premaxilla, P1 and P2 alveoli relative to one another: P1 and P2 not on same plane, with P2 being posterolateral (0); both alveoli on same transverse plane (1); P2 alveolus anterolateral to P1 alveolus (2)

299. Premaxilla, shape of anterior margin between P2-P3 alveoli: lateral margins curved, P3 either in-line, posteromedial or posterolateral to P2 (0); lateral margins subrectangular, P3 lateral to P2 (1)

300. Third premaxillary alveoli, relative size (when three or more alveoli present): not enlarged relative to second and fourth premaxillary alveoli (0); third alveoli enlarged (1)

301. Premaxilla, tooth row: alveoli along anterior and lateral margins (0); slight semi-circle, P5 directed posteriorly, and premaxilla with distinct lateral margins (1); slight semi-circle, premaxillary alveoli restricted to anterior and anterolateral margins (2); premaxillary tooth row restricted in tight curve, P5 being lateral to P4 and somewhat laterally oriented (3)

302. Number of teeth partially supported by premaxilla and maxilla: none (0); one (1)

303. Presence of premaxillary lamina extending posteriorly along palatal surface and overlaps anterior margin of first maxillary alveolus: absent (0); present (1)

304. Anterior margin of maxillary alveolus one: lacks interdigitating suture with premaxilla (0); has interdigitating suture with premaxilla (1)

305. Dentary alveolar count: 30 or more per rami (0); 20-29 (1); 15-19 (2); 14 or fewer (3)

306. Maxilla, anterior alveoli shape: subcircular (0); suboval (1)

307. Maxilla, interalveolar spaces, relative size: interalveolar spaces variable in size (0); interalveolar spaces uniformly narrow (1)

308. Dentary tooth row, distinctly sigmoidal: no (0); yes (1)

309. Dentary alveoli one, orientation: dorsally oriented (0); mainly dorsally oriented, with slight anterior orientation (1); strongly anteriorly oriented (procumbent) (2)

310. Dentary interalveolar spaces, relative size: interalveolar spaces variable in size (0); interalveolar spaces uniformly narrow (1)

311. Dentary alveoli, diastema between first and second alveoli: absent (0); present (1)

312. Dentary alveoli 1-2, confluence: well separated (0); confluent, separated by thin alveolar wall and apart from neighbouring teeth (1)

313. D2 alveoli, size relative to D1 alveoli: similar in size (0); reduced in size (1)

314. D3 alveoli, position: interalveolar space between D2 and D3 approximately equal to that between D3 and D4 (0); closer to D4 (1)

315. Interalveolar space between D2 and D3 alveoli relative to that of D1 and D2 alveoli: approximately equal (0); D2-D3 interalveolar space longer (1)

316. D4 alveolar wall: level with adjacent alveoli (0); raised relative to adjacent alveoli (1)

317. Dentary alveoli, diastema present between fourth and fifth alveoli: absent (0); present (1)

318: D7 alveoli, size: similar size to adjacent alveoli (0); reduced in size compared to adjacent alveoli (1)

319. D7 alveoli, position: similar to adjacent alveoli (0); close to eighth alveoli (1)

320. Dentary alveoli, number of alveoli adjacent to mandibular symphysis: 15 or more (0); 10 to 14 (1); 7 to 9 (2); 4 to 6 (3); fewer than 4 (4)

321. Premaxilla-anterior maxillary tooth crown apicobasal length to basal width ratio: 3 or greater (0); 2.5 or less (1)

322. Anterior maxilla, crown size: crown not enlarged (0); moderately enlarged (1); enlarged (2)

323. Anterior maxilla, mediolateral compression/crown cross section: no mediolateral compression (0); weak mediolateral compression (1); strong mediolateral compression (2)

324. Anterior maxilla, constriction at base of crown: absent (0); present (1)

325. Maxillary teeth, orientation of anterior to mid-rostrum crowns: not procumbent (0); procumbent (1)

326. Posterior maxilla, presence of enamel bands: absent (0); present (1)

327. Anterior maxilla, tooth crown tip: sharp or worn (0); blunt and rounded (1)

328. Dentary tooth opposite to premaxilla-maxilla contact, isometry: subequal to neighbouring teeth (0); tooth enlarged, anisometric relative to neighbouring teeth (1)

329. Dentary tooth opposite to premaxilla-maxilla contact, length: small to medium sized, length no more than twice that of neighbouring teeth (0); hypertrophied, at least twice as long as neighbouring teeth (1)

330. Dentary tooth opposite to premaxillary-maxillary suture, occlusion: occludes, either in notch, or lateral to premaxilla-maxilla suture (0); occludes in pit between premaxilla and maxilla (1); occludes medial to premaxilla-maxilla suture but not in pit/notch (2)

331. Dentary tooth occluding against premaxillary-maxillary suture: third or anterior (0); fourth (1); fifth or posterior (2)

332. Dentition, relation to tooth rows: one continuous set of teeth, both in cranium and mandible (0); two distinct sets (1)

333. Posterior maxillary teeth, transverse section: lateral compression affecting both edges of crown (0); transverse section circular to subcircular (1); transverse section 'teardrop-like' (2)

334. Mid to posterior mandibular teeth, transverse section: lateral compression affecting both edges of crown (0); transverse section circular to subcircular (1); transverse section 'teardrop-like' (2)

335. Dentition, labial surface, apicobasal facets: absent, either lacking facets or facetted into 4-5 indistinct planes (0); present, most facetted into three planes (1)

336. Dentition, presence of laminar teeth: absent (0); present (1)

337. Dentition, presence of spatulated teeth: absent (0); present (1)

338. Dentition, presence of tribodont teeth in posterior maxillae and dentaries: absent (0); present (1)

339. Dentition, presence of carinae on apical third: absent (0); present (1)

340. Dentition, presence of enamel ridges on apical third: absent (0); present (1)

341. Mid to posterior dentition, presence of pebbled ornamentation on tooth crown surface: absent (0); present (1)

342. Mid to posterior dentition, labial-lingual surfaces, presence of accessory ridges on tooth crown: absent (0); present (1)

343. Mid to posterior dentition, number of cusps per tooth: single apical cusp (0); one main cups with smaller cusps, arranged in single row (1); several cusps, unequal in size, arranged in more than one row (2); several small cusps, subequal in size, along occlusal edges (3)

344. Tooth wear, macroscopic wear along carinae/mesiodistal margins: absent (0); present (1)

345. Anterior-middle dentition, tooth crown curvature: none (0); weakly recurved (1); strongly recurved (2)

346. Carinae, presence of keel at edge of tooth crown: absent (0); present (1)

347. Carinae, presence of carinal flanges: absent, external surface convex/straight (0); poorly developed, external surface becomes concave immediately adjacent, unequally expressed on labial and lingual surfaces (1); well developed, external surface becomes concave immediately adjacent, present on both labial and lingual surfaces (2)

348. Carinae, height of keel in apical region: keel absent or not greatly enlarged (0); keel greatly enlarged in height (1)

349. Carinae, presence of false ziphodont serrations at crown edges: absent across dentition (0); present, restricted to posterior end of tooth row (1); present across dentition (2)

350. Carinae, presence and development of true denticles at crown edges: absent (0); incipient denticles, poorly defined (1); well-defined denticles (2)

351. Carinae, mid-posterior dentition, denticles at crown edges: carinae and/or denticles absent, or homologous carina (0); heterogeneous carina, tubercle-like truce denticles that do not form series (1); heterogeneous carina, cuneiform or ripple-like true denticles, form short rows of 2-10 denticles and do not proceed contiguously (2); homogenous carina, cuneiform or ripple-like true denticles, form continuous series (3)

352. Carinae, lingual or labial view, true denticles shape: chisel-shaped or rectangular (0); rounded (1)

353. Carinae, denticles distribution across dentition: all or most teeth lack denticles (0); all teeth microziphodont (1); all teeth macroziphodont (2); teeth show variation in denticle size (3)

354. Carinae, maxillae, distribution of denticles at crown edges: mesial and distal crown edges with same morphology (0); mesial carina absent and distal carina present (1)

355. Carinae, mid-posterior mandible, distribution of denticles at crown edges: mesial and distal crown edges with same morphology (0); mesial carina present and distal carina absent (1)

356. Occlusion, relation between maxillary and dentary series: in-line or interlocked (0); maxillary dentition overbites dentary dentition (1)

357. Enamel surface ornamentation, apicobasal ridges: absent macorscopically (0); present macroscopically, enlarged 'rippled' morphology (1); largely inconspicuous, short, well-spaced, well-defined (2); numerous, aligned, low relief (3); conscious, elongate, well-defined (4); noticeable difference between labial and lingual surfaces (5)

358. Apical enamel surface ornamentation, macroscopic anastomosed pattern: absent (0); present and strongly developed, only in apical region of crown (1)

359. Maxillary teeth, occurrence of bilateral paramesial rotation: absent (0); up to 30-degrees from original plane (1); over 30-degrees from original plane (2)

360. Middle and posterior mandible teeth, occurrence of bilateral paramesial rotation: not oblique or slightly altered (0); oblique (1)

361. Middle and posterior teeth, presence of cingula with accessory cusps: absent (0); present (1)

362. Enamel surface ornamentation, 'pseudodenticles': absent (0); present (1)

Axial post-cranial skeleton

363. Atlas, hypocentrum length: long, >15% of odontoid process length (0); short, subequal to odontoid process length (1)

364. Axis, neural arch diapophysis: absent (0); present (1)

365. Presacral vertebrae number: 24 (0); 25 (1)

366. Number of cervio-dorsal vertebrae where parapophysis are borne on centrum, including atlas-axis: 9 or 10 (0); 8 (1); 7 (2)

367. Cervical vertebrae, hypapophysis: present (0); reduced (1)

368. Cervical vertebrae, shape: amphicoelous or amphyplatian (0); weakly procoelous (1); strongly procoelous (2)

369. Posterior cervical vertebrae, centrum length vs width: long, centrum length more than 1.5x width (0); moderate, centrum length and width subequal (1); short, centrum length less than 95% width (2)

370. Middle cervical vertebrae, neural spine height relative to centrum height: neural spine height greater than centrum height (0); neural spine and centrum heights approximately equal (1); neural spine height less than centrum height (2)

371. Number of cervico-dorsal vertebrae where parapophyses are borne partially, or solely, on neural arch ('thoracic vertebrae'): 12 (0); 13 (1); 14 (2); 15 (3)

372. Number of cervico-dorsal vertebrae posterior to "thoracic vertebrae" and anterior to sacral vertebrae where parapophyses no longer borne on neural arch ('lumbar vertebrae'): two (0); three (1); four (2)

373. Thoracic and lumbar vertebrae, shape: amphicoelous or amphyplatian (0); weakly procoelous (1); strongly procoelous (2)

374. Thoracic vertebrae, shallow fossa on anterior margin of diapophysis immediately lateral to parapophysis: present (0); absent (1)

375. Thoracic vertebrae, orientation of parapophysis: posteriorly or horizontally (0); anteriorly (1)

376. Anterior thoracic vertebrae, lateral view, parapophysis in relation to diapophysis: parapophyisis ventral to, or level with, diapophysis (0); parapophysis dorsal to diapophysis (1)

377. Anterior thoracic vertebrae, neural spine height relative to centrum height: neural spine and centrum heights raltively equal (0); neural spine height less than centrum height (1)

378. Dorsal vertebrae, shape and position of neural spines: neural spines with 'normal' shape, elongate, dorsal margin convex and neural spines of adjacent dorsals separated from one another (0); neural spines all rectangular, flat dorsal margins and neural spines of adjacent dorsals close to one another (1)

379. Sacral vertebrae, number: tow (0); three (1)

380. Sacral vertebrae, shape of centra posterior face: circular to subcircular (0); distinctly oval (1)

381. Caudal vertebra, shape of caudal vertebra I: amphicoelous or amphyplatian (0); biconvex (1); procoelous (2)

382. Caudal vertebra, shape of caudal vertebrae posterior to first caudal: all amphicoelous or amphyplatian (0); mixture of semi-procoelous, amphicoelous or amphyplatian (1); all procoelous (2)

383. Caudal vertebrae, number: less than 46 (0); 50 or more (1)

384. Caudal vertebrae, relative height of neural spine: larger spines up to 2.5x height og vertebral body (0); spines 2.5-4x height of vertebral body (1)

385. Caudal vertebrae, shape and orientation of neural spines immediately in front of flexural caudal vertebrae: neural spines largely similar in shape to other preflexural caudal

vertebrae, with slight posterior orientation (0); neural spines of vertebrae immediately in front of tail bend have distinct morphology (dorsoventrally low, strongly inclined posteriorly) (1); neural spines of five-to-six vertebrae immediately in front of tail bend have distinct morphology (dorsoventrally low, strongly inclined posteriorly) (2)

386. Caudal vertebrae, abrupt change in centrum cross-section at distal end of column: centra retain subcircular to suboval cross section (0); abrupt change in centrum shape, with strong mediolateral compression (1)

387. Caudal vertebrae, shift in neural spine inclination near distal end: no shift (0); yes, distinct shift (1)

388. Caudal vertebrae, ventral deflection of distal end: absent (0); present, tail bend angle less than 10-degrees (1); present, tail bend angle between 10-140 degrees (2); present, tail bend angle greater than 40-degrees (3)

389. Caudal vertebrae, number of vertebrae involved in tail deflection: no ventral deflection (0); deflection large, over 15 to 30 vertebrae (1); deflection abrupt, over 5 to 10 vertebrae (2)

390. Caudal vertebrae, rapid centrum anteroposterior length reduction in postflexural caudal vertebrae: centra become progressively 'smaller' in anteroposterior length and dorsoventral height (0); centra become 'smaller' (1)

391. Axis rib: holocephalous (0); dichocephalous (1)

392. Axis rib, tuberculum: wide with broad dorsal tip (0); narrow with acute dorsal tip (1)

393. Atlantal ribs, anterior end, presence of thin medial laminae: absent (0); present (1)

394. Cervical ribs, lateral view, anteroposterior ridge of large, more posteriorly placed cervical ribs: straight (0); dorsoventrally curved (1)

395. Dorsal ribs, positioning of tuberculum and articular facet: medial edge (0); directly in middle (1); lateromedial edge (2)

396. Dorsal ribs, lateral view, size of tuberculum: pronounced (0); shallow (1)

397. Sacral vertebrae, position of lateral end of transverse processes: level with vertebral column (0); transverse processes of sacra vertebra one lateroventrally directed (1); transverse processes of both sacral vertebrae lateroventrally directed (2)

398. Second sacral vertebrae, posterior flange on rib: anterior margin has a small, non-expanding flange (0); anterior margin has a large, expanded projecting flange (1)

399. Chevrons, shape near distal end of caudal series: subtriangular or rod-like in lateral view, 'V' or 'Y' shaped in anterior view (0); mediolaterally compressed in lateral view, slight 'W' shape in anterior view (1)

400. Chevrons, presence of notch on ventral margin of distal chevrons: absent (0); present (1)

401. Chevrons, contact in distal chevrons: if adjacent chevrons contact, along posterior-anterior margins (0); adjacent chevrons contact along posteroventral-anterodorsal margins (1)

Appendicular skeleton: pectoral girdle and forelimbs

402. Coracoid, shape: neither proximal nor distal ends are fan-shaped (0); distal end convex (1); both proximal and distal ends convex (2)

403. Coracoid, postglenoid process: short (0); elongate and expanded posteriorly (1); elongate and expanded anteriorly and posteriorly (2)

404. Coracoid, posteroventral edge, deep groove: absent (0); present (1)

405. Scapula blade: large approximately twice the width of scapular shaft an generally wider than distal glenoid region (0); scapula blade reduced, as wide as, or narrower than, glenoid region (1); scapular blade reduced, blade broadens both anteriorly and posteriorly but still as wide as, or narrower than, glenoid region (2)

406. Scapula, lateral view, anterior and posterior margins: symmetrically concave (0); anterior edge more strongly concave than posterior edge (1); posterior edge more strongly concave than anterior edge (2)

407. Scapula, deltoid crest: present (0); absent (1)

408. Scapula/humerus, size: humerus longer than scapula (0); humerus and scapula subequal (1); humerus shorter than scapula (2)

409. Limb bones, proportional length of ulna relative to humerus: ulna longer than humerus (0); ulna subequal in length to humerus (1); ulna shorter than humerus (2)

410. Humerus, proximal region: confined to proximal surface (0); posteriorly expanded and hooked (1); strongly deflected and hooked (2)

411. Humerus, proximomedial articular surface: strongly convex (0); weakly convex (1)

412. Humerus, deltopectoral crest: present and distinct from proximal surface (0); present but continuous with proximal surface (1)

413. Humerus, shape: typical long bone morphology, longer than wide at distal end (0); broadly expanded and plate-like (1)

414. Humerus, length of diaphysis relative to total humerus length: diaphysis contributes >50% total humeral length (0); diaphysis contributes 35-38% total humeral length (1); diaphysis contributes <25% total humeral length (2)

415. Humerus-antebrachium joint surface: complex, allowing one degree of motion (0); planar, limiting motion (1)

416. Radius and/or ulna, shape: typical long bone morphology, proximodistal length greater than width at distal end (0); broadly expanded and plate-like (1)

417. Radius and ulna, length relative to one another: relatively same size (0); ulna >25% larger than radius (1)

418. Ulna, axis length: proximodistal axis length greater than anteroposterior axis length (0); anteroposterior axis length greater than proximodistal axis length (1)

419. Ulna, olecranon process: narrow and subangular (0); wide and rounded (1)

420. Ulna, olecranon process mediolaterally compressed and greatly expanded: no (0); yes (1)

421. Radiale and/or ulnare, shape: typical long bone morphology, proximodistal length greater than width at distal end (0); broadly expanded and plate-like (1)

422. Manus, metacarpal structure: metacarpals IV and V not strongly differentiated from II-III (0); metacarpals II-III noticeably more robust than IV-V (1)

423. Manus, shape of metacarpal I: elongate (0); broadly expanded (1)

424. Manus, digit I: present (0); absent (1)

425. Manus, relative length of digit V: digit V longer than digit I, comparable in length to digits II-IV (0); digit V reduced in length, shorter than digits II-IV and comparable in length to digit I (1)

Appendicular skeleton: pelvic girdle and hind limbs

426. Pubis, exclusion from acetabulum: pubis not excluded (0); pubis excluded (1)

427. Pubis, presence of exclusive proximal contact with ischium: absent, pubis supported by both ilium and ischium (0); present, proximal head of pubis contacts only ischium (1)

428. Pubis, length: <70% femoral length (0); ≥70% femoral length (1)

429. Pubis, expansion of distal end: absent (0); expanded relative to shaft into pubic boot (1); 'fan-like' expansion (2)

430. Pubis, shape of proximal rim of distal pubic blade: straight and square-like (0); curved and rounded (1)

431. Pubis, length of pubic shaft: <50% pubic plate (0); ≥50% pubic plate (1)

432. Pubis, presence of obturator foramen: present (0); absent (1)

433. Ilium, presence of distinct anterior acetabular flange: absent (0); present (1)

434. Ilium, shape of anterior iliac process: long and slender (0); short and robust (1)

435. Ilium, relative length of anterior and posterior processes: subequal (0); unequal, anterior process relatively small (1)

436. Ilium, presence of indentation at dorsal margin of iliac blade: absent, dorsal margin convex or straight (0); present as shallow or modest indentation (1); present as strong indentation ('wasp-waisted') (2)

437. Ilium, presence of distinct 'bulge', fuses anterior regions of supraacetabular dorsal iliac crests: anterior region of supraacetabular crest does not fuse with anterior margin of iliac dorsal margin, no anterior 'bulge' (0); anterior region of supraacetabular crest bulges laterally and contiguous with anterior margin of iliac dorsal crest (1)

438. Complexity of supraacetabular iliac crest, medial view: crest pronounced (0); crest shallow and poorly developed (1)

439. Ilium, postacetabular process, presence: present (0); absent/extremely reduced (1)

440. Ilium, postacetabular process expanded into thin 'fan': no (0); yes, posterior margin expanded (1)

441. Ilium, postacetabular process, presence of constrictions on dorsal and ventral margins near distal terminus: absent (0); present (1)

442. Ilium, size: large, dorsal border at least 31% femoral length (0); small, dorsal border less than 21% femoral length (1)

443. Ilium, lateral view, orientation of dorsal margin of articulation facet that contributes to acetabulum: ventrally oriented (0); horizontally oriented (1)

444. Ilium, lateral view, dorsal border length: long, terminates level to articulation facet (0); short, terminates prior to articulation facet (1)

445. Ilium, ventral margin: distinct ilium and ischium peduncles separated by acetabular incision (0); lacks acetabular depression, peduncles contiguous (1)

446. Ischium, presence of pubic process: pubic process absent, or incipient and small (0); anterior process well developed, robust with a rounded head (1)

447. Ischium, pubic anterior process: developed, clearly defined articulation facets, anterior process at least ½ as wide as posterior process (0); reduced, lacks both articulations facets, anterior process between 30-50% as wide as posterior process (1); highly reduced, lacking both articulation facets, anterior process <35% as wide as posterior process (2)

448. Ischium, lateral view, anterior process of iliac blade: very narrow (0); rounded and moderately broad (1); very broad and deep (2)

449. Ischium, shape of posteroventral margin of ischial plate: triangular (0); subsquare (1)

450. Limb bones, length relative to trunk, maturity: limb bones relatively short (0); limb bones moderately long (1); limb bones very long (2)

451. Lomb bones, structure: robust (0); overall slender, but not weak (1); gracile (2)

452. Lomb bones, length of forelimbs/hindlimbs at maturity: forelimb and hindlimb subequal in length (0); forelimb slightly shorter than hindlimb (1); forelimb shorter than hindlimb (90 and 55%) (2); forelimb noticeably shorter than hindlimb (45 and 55%) (3); forelimb significantly shorter than hindlimb (<45%) (4)

453. Limb bones, tibia length relative to femur length: length uneven, tibia slight longer than femur (0); tibia subequal in length to femur (1); length uneven, tibia evidently shorter than femur (~50-74%) (3); length uneven, tibia evidently shorter than femur (~30-40%) (4); length uneven, tibia evidently shorter than femur (<30%) (5)

454. Femur, orientation between proximal and distal heads: light torsion, proximal and distal articulation facets approximately ≤30 degrees from each other (0); evident torsion, proximal and distal articulation facets approximately 60-degrees from each other (1)

455. Femur, shape: sigmoidal shape formed by either unequal proximal and distal curvature, or strong sigmoidal shape (0); sigmoidal shape formed by comparable curvatures proximally and distally, forms shallow ‘S’-shape (1)

456. Femur, dorsal view, shape of femoral head relative to anteromedial tuber: present and small (0); present and largest (1)

457. Femur, proximal portion, posteromedial tuber: absent (0); present and small (1); present and largest (2)

458. Femur, proximal condylar fold: absent (0); present (1)

459. Femur, size of distal medial and lateral condyles relative to one another: relatively same size (0); medial condyle larger than lateral condyle (1)

460. Femur, ridge of attachment for *M. caudofemoralis*: absent, flattened rugose area (0); low and without distinct medial asymmetrical apex (1); blade-like with distinct asymmetric apex located medially (2)

461. Femur, lateral edge of proximal articular surface: rounded (0); squared, with enlarged scar (1)

462. Femur, medial condyle of distal portion: tapers to point on medial portion in distal view (0); smoothly rounded in distal view (1); condyle incompletely ossified, and poorly developed (2)

463. Femur, distal surface between lateral and medial condyles: nearly flat or flat (0); groove separating medial and lateral condyles (1)

464. Tibia, lateral view, angle of tibial tuberosity: horizontal (0); ventral (1)

465. Calcaneum tuber, development: well developed with long neck (0); poorly developed with short neck (1)

466. Calcaneum, size of calcaneum tuber relative to astragalus: subequal in size (0); tuber ≥25% larger than astragalus (1)

467. Pes, length of metatarsals: metatarsals I-IV longer (>20%) than respective phalanges (0); metatarsals II-IV subequal (± 10%) in length to respective phalanges (1); metatarsals II-IV shorter (<90%) than respective phalanges (2)

468. Pes, proximal morphology of metatarsal I: not enlarged (0); enlarged, 25-30% wider (1); moderately enlarged, 45-55% wider (2); greatly enlarged, >75% wider (3)

469. Pes, length of digits III and IV: digit III longer than digit IV (0); digit IV longer than digit III (1)

470. Pes, digit V, number of phalanges: six (0); five (1); four or fewer (1)

471. Pes, digit V, metatarsals and phalanges: present and fully developed first phalanx (0); present and poorly developed first phalanx (1); without phalanges and metatarsal tapers to a point (2)

Dermal ossifications: osteoderms

472. Dorsal osteoderms, ornamentation, type of sculpture: vermiform-dendritic pattern (0); pitted pattern (1)

473. Dorsal osteoderms, ornamentation, dorsal surface, distribution of pits: small round to ellipsoid pits, densely distributed (0); large round to ellipsoid pits, well separated (1); irregularly shaped pits, with extreme variation in size, with elongate pits present on ventrolateral surface (2); pits variable in size and length (small to large), on osteoderms with a keel pits become elongate grooves, especially along lateral margins (3)

474. Presacral osteoderms, dorsal to vertebral column: absent (0); present (1)

475. Presacral ventral osteoderms, form a carapace in trunk region: absent (0); present (1)

476. Nuchal armour, relation of nuchal osteoderms with remaining dorsal armour and skull: large nuchal shields continuous from postoccipital region to trunk armour, with any given osteoderm contacting anterior and posterior elements (0); large nuchal shields continuous with trunk armour, but not reaching postoccipital region (1); large nuchal

shields discontinuous with dorsal trunk armour and absent from postoccipital region (2)

477. Nuchal armour, number and arrangement of nuchal shields: four paramedian shields, sided by two accessory shields, all enlarged (0); four paramedian shields enlarged relative to remaining neck shields, no accessory shield enlarged (1); eight (or more) shields, arranged in two paramedian rows, enlarged relative to remaining neck shields with no accessory shield enlarged (2); ten or more median osteoderms, combined with several lateral osteoderms (3)

478. Nuchal armour, morphology of nuchal shields relative to remaining trunk dermal armour: nuchal and trunk shields undifferentiated (0); nuchal and trunk shields differentiated from dorsal trunk by size and morphology (1)

479. Presacral dorsal armour, medial dorsal elements, presence of anterior process to articulate with anterior adjacent osteoderm: absent (0); present as distinct 'peg-like' process (1); present as indistinct process, lateral margin contiguous with other osteoderm ventrolateral surface (2)

480. Presacral dorsal armour, surface of paravertebral osteoderms: weakly arched or mostly straight, forming flat osteoderm, either keeled or not (0); strongly curved with convex surface and partially embracing vertebrae on both sides, or curvature restricted to distinct bend near lateral edge (1)

481. Presacral dorsal armour, biserial or tetraserial dorsal shield: biserial (0); tetraserial (1)

482. Presacral dorsal armour, presence of accessory osteoderm columns that do not have a peg-like articulation with the paramedian column: absent (0); present, one lateral accessory column (1); present, two lateral accessory columns (2)

483. Presacral dorsal armour, presence of accessory osteoderm that has a peg-like articulation with the paramedian column: absent (0); present, one lateral accessory column on either side of paramedian columns, with articulations (1)

484. Presacral dorsal armour, presence of accessory osteoderm columns, anteriorly two lateral accessory columns: absent (0); present (1)

485. Presacral dorsal armour, dimensions of thoracic osteoderms: squared-shaped, width and length approximately equal (0); longer than wide (1); wider than long (2)

486. Presacral dorsal armour, transverse elongation of thoracic osteoderms: either small or subequal to anteroposterior length, or slightly wider (0); considerably wider than long, approximately 3x anteroposterior length (1)

487. Presacral dorsal armour, contact between elements in a row: imbricated (0); sutured (1)

488. Presacral dorsal armour, presence of anteroposteriorly directed keel on dorsal surface of paramedial elements: absent in approximately ½ to all of paravertebral osteoderms, or if present hard to discern 90); present along more than ½, to all, of paravertebral osteoderms (1)

489. Sacral dorsal armour, dorsal surface, length and size of keel: elongate and shallow keel (0); elongate and pronounced keel (1)

490. Presacral ventral armour, presence of ventral collar scales: absent, no shield enlarged relative to other ventral scales (0); present, forms single row of enlarged scales (1); present, forms two parallel rows of enlarged scales (2)

491. Presacral ventral armour, paired ossifications: single or absent (0); present, pairs sutured together (1)

492. Caudal armour, distribution of dorsal tail osteoderms: present (0); absent (1)

493. Caudal armour, distribution of ventral tail osteoderms: present (0: absent (1)

494. Caudal armour, distribution when present: pair of rows, covering vertebral column (0); several rows, enclosing tail surface (1)

495. Caudal armour, dorsal surface, presence of anteroposteriorly directed keel on paramedial elements: absent (0); present (1)

496. Appendicular armour, presence of osteoderms on limbs: absent (0); present (1)

Dermal ossifications: gastralia

497. Gastralia: form extensive ventral basket with closely packed elements (0); well separated (1); absent (2)

Soft tissue

498. Iris colour: greenish/yellowish (0); brown (1)

499. Tongue, presence of keratinised surface: absent (0); present (1)

500. Functional lingual salt glands: absent (0); present (1)

501. *M. caudofemoralis*: with single head (0); with double head (1)

502. Skin colour: no, or very little, skin coloration change (0); dorsolateral skin surfaces change to lighter colour in light environment (1); dorsolateral skin surface changes to darker colour in light environment (2)

APPENDIX S2.2 – SUPPLEMENTARY INFORMATION

ONLINE SUPPLEMENTARY MATERIAL (OSM)

by Michela M. Johnson[1]

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S1) CrocSuperMatrix Project Overview

S2) Hastings + Young (H+Y) dataset

S2.1) H+Y dataset – general information and scoring sources of the OTUs

S2.2) H+Y dataset – character list

S3) Character and OTUs breakdowns of the merged, and parent, datasets

S4) Supplementary References

S5) List of institutional abbreviations

S1) CrocSuperMatrix Project Overview

Thus far, two datasets have been successfully merged; those of Alexander Hastings and Mark Young (see Ristevski *et al*., 2018). This has formed the Hastings and Young dataset (referred to herein as the H+Y matrix).

Currently, four datasets are in the process of being merged. The first two are the H+Y dataset and a modified version of the Andrade *et al*. (2011) dataset (herein referred to as the mA matrix). The first iteration of the H+Y and mA matrices were published in Ristevski *et al*. (2018).

The third dataset, is a modification of the dataset published by Wilberg (2017), (herein referred to as the mW matrix). Note that Ősi *et al*. (2018) was the first paper to have all three of these datasets together, however therein the Wilberg (2017) dataset had not been re-structured to be the same as H+Y and mA datasets. Note that here we have done so, and also created two new sub-sections: 1) internal neuroanatomy, sensory systems and cranial exocrine glands, and 2) craniomandibular pneumaticity.

A fourth dataset has also been added, the “basal crocodylomorph” or BC dataset. This is an expansion of the dataset first published by Clark *et al*. (2000), and recently elaborated upon by Pol *et al*. (2013) and Leardi *et al*. (2017).

The characters for both datasets have been organised into a common anatomical order, and broken down into the same 20 sub-sections:

1) skull geometry and dimensions
2) craniomandibular ornamentation
3) internal neuroanatomy, sensory systems and cranial exocrine glands
4) craniomandibular pneumaticity
5) rostral neurovascular foramina
6) cranial rostrum
7) skull roof
8) orbit and temporal region
9) palate and perichoanal structures
10) occipital
11) braincase, basicranium and suspensorium
12) mandibular geometry
13) mandible
14) dentition and alveolar morphologies
15) axial post-cranial skeleton
16) appendicular skeleton: pectoral girdle and forelimbs
17) appendicular skeleton: pelvic girdle and hind limbs
18) dermal ossifications: osteoderms
19) dermal ossifications: gastralia
20) soft tissue

Herein we only use the H+Y dataset, as a larger paper on this project is currently in preparation.

S2) Dataset one: Hastings + Young (H+Y)

S2.1) H+Y dataset – general information and scoring sources of the OTUs

The present list includes information for each operational taxonomic unit (OTU) included in the matrix. Fragmentary taxa (i.e. ones that are highly incomplete) are mentioned as: [fragmentary taxon].

OUTGROUP TAXON

RAUISUCHIDAE (1 OTU)

(1) *Postosuchus kirkpatricki* Chatterjee, 1985
DATA FROM: Nesbitt (2011), Weinbaum (2011), Weinbaum (2013).
LOCALITY: Post (=Miller) Quarry, Texas, USA.
FORMATION: Cooper Canyon Formation, Dockum Group.
AGE: Norian, Late Triassic.

INGROUP TAXA

BASAL CROCODYLOMORPHS (= 'SPHENOSUCHIANS' *SENSU LATO*) (5 OTUs)

(2) *Carnufex carolinensis* Zanno et al., 2015
DATA FROM: NCSM 21558 (holotype); NCSM 21623; Drymala & Zanno, 2016.
LOCALITY: southeastern Chatham County, North Carolina, USA.
FORMATION: Pekin Formation, Chatham Group, Deep River Basin.
AGE: Carnian, Late Triassic.

(3) *Dromicosuchus grallator* Sues *et al*., 2003
DATA FROM: Sues *et al*. (2003), Nesbitt (2011).
LOCALITY: West Genlee, Durham County, North Carolina, USA.
FORMATION: Mudstone of Lithofacies Association II, Newark Super-Group. South-central region of Durham sub-basin of Deep River Basin.
AGE: upper Carnian or lower Norian, Late Triassic.

(4) *Hesperosuchus* cf. *agilis*
DATA FROM: CM 29894; Clark *et al*. (2000), Nesbitt (2011).
LOCALITY: *Coelophysis* Quarry, Ghost Ranch, northern New Mexico, USA.
FORMATION: "siltstone member", Chinle Formation.
AGE: upper Norian–?Rhaetian, Late Triassic.

(5) *Terrestrisuchus gracilis* Crush, 1984
DATA FROM: Crush (1984), Nesbitt (2011).
LOCALITY: Pant-y-ffynon Quarry, Cowbridge, Glamorgan, Wales, UK.
FORMATION: fissure fills in Carboniferous limestone.
AGE: ?Rhaetian, Late Triassic.

(6) *Dibothrosuchus elaphros* Simmons, 1965
DATA FROM: Wu (1986); Nesbitt (2011).

LOCALITY: Huangchiatien, Lufeng, Yunnan, China.
FORMATION: Zhangjiawa Formation, Lower Lufeng Group.
AGE: Sinemurian–Pliensbachian, Lower Jurassic.

(7) *Junggarsuchus sloani* Clark *et al*., 2004
DATA FROM: photographs of the holotype provided by Eric Wilberg; Clark *et al*. (2004).
LOCALITY: Wucaiwan, Altay Prefecture, Xinjiang Province, NW China.
FORMATION: lower part of the Shishugou Formation (= Wucaiwan Formation).
AGE: Bathonian–Callovian, Middle Jurassic.

BASAL CROCODYLIFORMS: 'PROTOSUCHIANS' *SENSU LATO* (4 OTUs)

(8) *Hemiprotosuchus leali* Bonaparte, 1971
DATA FROM: Bonaparte (1971).
LOCALITY: Quebrada de los Jachaleros, W La Rioja Province, Argentina.
FORMATION: Los Colorados Formation.
AGE: Coloradense, Norian, Upper Triassic.

(9) *Protosuchus richardsoni* Brown, 1933
DATA FROM: Colbert & Mook (1951), Nesbitt (2011).
LOCALITY: Ward's Terrace, Arizona, USA.
FORMATION: upper half of the Moenave Formation, Glen Canyon Group.
AGE: Hettangian, Lower Jurassic.

(10) *Protosuchus haughtoni* (Busbey & Gow, 1984)
DATA FROM: Gow (2000), Nesbitt (2011).
LOCALITY: South Africa.
FORMATION: Upper Elliot Formation.
AGE: Lower Jurassic.

(11) *Eopneumatosuchus colberti* Crompton & Smith, 1980
DATA FROM: Crompton & Smith (1980); high-resolution images of the holotype provided by Lawrence Witmer.
LOCALITY: 11 miles NE of Cameron, Coconino County, Arizona, USA.
FORMATION: 'Silty facies', Kayenta Formation, Glen Canyon Group.
AGE: Sinemurian-Pliensbachian, Lower Jurassic.

BASAL CROCODYLIFORMS: SHARTEGOSUCHIDAE (1 OTU)

(12) *Fruitachampsa callisoni* Clark, 2011
DATA FROM: Clark (2011).
LOCALITY: Fruita, Colorado, USA.
FORMATION: Morrison Formation.
AGE: Upper Jurassic.

NOTOSUCHIA: 'NOTOSUCHIDAE' (2 OTUs)

(13) *Notosuchus terrestris* Woodward, 1896

DATA FROM: MACN-Pv-N-22, MACN-Pv-N-23, MACN-Pv-N-24, MACN-Pv-N-43, MACN-Pv-N-107, MACN-Pv-RN-1015, MACNPv-RN-1037, MACN-Pv-RN-1038, MACN-Pv-RN-1039, MACN-Pv-RN-1040, MACN-Pv-RN-1041, MACN-Pv-RN-1043, MACN-Pv-RN-1044, MACN-Pv-RN-1045, MACN-Pv-RN-1046, MACN-Pv-RN-1047, MACN-Pv-RN-1048, MACN-Pv-RN-1118, MACN-Pv-RN-1119, MLP-64-IV-16-1, MLP-64-IV-16-5(253) (lectotype), MLP-64-IV-16-6(203), MLP-64-IV-16-7(219), MLP-64-IV-16-8(209), MLP-64-IV-16-9(201), MLP-64-IV-16-10(221), MLP-64-IV-16-11, MLP-64-IV-16-12, MLP-64-IV-16-13, MLP-64-IV-16-14, MLP-64-IV-16-15, MLP-64-IV-16-16, MLP-64-IV-16-17, MLP-64-IV-16-18, MLP-64-IV-16-20, MLP-64-IV-16-21, MLP-64-IV-16-22, MLP-64-IV-16-23, MLP-64-IV-16-24, MLP-64-IV-16-25, MLP-64-IV-16-28, MLP-64-IV-16-30, MLP-64-IV-16-31(206), MPCA-Pv-528; MPCA-Pv-789/1; MPCA-Pv-791; Woodward (1896), Gasparini (1971), Bonaparte (1991, 1996), Andrade & Bertini (2008b), Fiorelli & Calvo (2008).
LOCALITIES: several outcrops in the Neuquén and Rio Negro provinces, Argentina
FORMATION: Bajo de La Carpa Formation, Neuquén Group. Neuquén Basin.
AGE: Santonian–Campanian, Upper Cretaceous.

(14) *Mariliasuchus amarali* Carvalho & Bertini, 1999
DATA FROM: MN-6298-V, MN-6756-V, UFRJ-DG-50-R(type), UFRJ-DG-56-R, UFRJ-DG-105-R, UFRJ-DG-106-R, UFRJ-DG-115-R, URC-R-67, URC-R-68, URC-R-69; Carvalho & Bertini (1999), Andrade (2005), Vasconcellos & Carvalho (2005).
LOCALITY: Rio do Peixe, São Paulo State, Brazil.
FORMATION: Aracatuba Formation, Bauru Group. Bauru Basin.
AGE: Campanian, Upper Cretaceous.

NOTOSUCHIA: SPHAGESAURIDAE (3 OTUs)

(15) *Adamantinasuchus navae* Nobre & Carvalho, 2006
DATA FROM: UFRJ-DG-107-R (type), UFRJ-DG-216-R; Nobre & Carvalho (2006).
LOCALITY: Rio do Peixe, São Paulo State, Brazil.
FORMATION: Aracatuba Formation, Bauru Group. Bauru Basin.
AGE: Campanian, Upper Cretaceous.

(16) *Sphagesaurus huenei* Price, 1950
DATA FROM: Pol (2003).
LOCALITY: N São Paulo State, Brazil.
FORMATION: Adamantina Formation, Bauru Group. Bauru Basin.
AGE: Campanian–Maastrichtian, Upper Cretaceous.

(17) *Caipirasuchus montealtensis* (Andrade & Bertini, 2008a)
DATA FROM: Andrade (2005), Andrade & Bertini (2008a), Iori *et al*. (2016).
LOCALITY: Monte Alto, N São Paulo State, Brazil.
FORMATION: Adamantina Formation, Bauru Group. Bauru Basin.

AGE: Campanian–Maastrichtian, Upper Cretaceous.

NOTOSUCHIA: BAURUSUCHIDAE (1 OTU)

(18) *Baurusuchus pachecoi* Price, 1945
DATA FROM: FEF-R-1-9; Price (1945), Carvalho *et al.* (2005; MPMA 62-0001-02).
LOCALITY: 72 km SW of Vila do Veadinho (type locality), Paulo de Faria city. and several other localities spread at the N-NW São Paulo State, Brazil.
FORMATION: Adamantina Formation, Bauru Group. Bauru Basin.
AGE: Campanian-Maastrichtian, Upper Cretaceous.
OBSERVATION: Here *B. salgadoensis* Carvalho *et al.* 2005 is treated as a subjective junior synonym of *B. pachecoi*.

NOTOSUCHIA: 'URUGUAYSUCHIDAE' (1 OTU)

(19) *Araripesuchus patagonicus* Ortega *et al.*, 2000
DATA FROM: MUCPv-267, MUCPv-268, MUCPv-269 (holotype); Ortega *et al.* (2000).
LOCALITY: El Chocon (Embalse Ezequiel Ramos Mexia), Neuquén Province, NW Patagonia, W Argentina.
FORMATION: Candeleros Member, Rio Limay Formation, Neuquén Group. Neuquén Basin.
AGE: Albian-Cenomanian, 'mid' Cretaceous.

NOTOSUCHIA: PEIROSAURIDAE (2 OTUs)

(20) *Montealtosuchus arrudacamposi* Carvalho *et al*., 2007
DATA FROM: Carvalho *et al.* (2007)
LOCALITY: Monte Alto, N São Paulo State, Brazil.
FORMATION: Adamantina Formation, Bauru Group. Bauru Basin.
AGE: Campanian–Maastrichtian, Upper Cretaceous.

(21) *Uberabasuchus terreficus* Carvalho *et al*., 2004
DATA FROM: Carvalho *et al.* (2004).
LOCALITY: Caieira outcrop, Peiropolis, Uberaba Municipality, S Minas Gerais State, SE Brazil.
FORMATION: Marilia Formation, Bauru Group. Bauru Basin.
AGE: Campanian–Maastrichtian, Upper Cretaceous.

NOTOSUCHIA: 'TREMATOCHAMPSIDAE' (1 OTU)

(22) cf. *Hamadasuchus rebouli* Buffetaut, 1994
DATA FROM: This OTU was scored for specimens referred to *H. rebouli* by Larsson & Sues (2007; mainly ROM-52620), not the type material. Therefore, the use of cf. *H. rebouli*.
LOCALITY: SE Morocco.
FORMATION: Kem Kem beds.
AGE: Albian–Cenomanian, 'mid' Cretaceous.

NOTOSUCHIA: SEBECIDAE (1 OTU)

(23) *Sebecus icaeorhinus* Simpson, 1937
DATA FROM: AMNH 3160 (cast); Larsson & Sues (2007).
LOCALITY: Canadon Hondo and Canadon Vaca, tributaries to the Rio Chico del Chubut, Chubut, Patagonia, Argentina.
FORMATION: Casamayor Formation.
AGE: early–middle Eocene, Paleogene.

NOTOSUCHIA: MAHAJANGASUCHIDAE (1 OTU)
(24) *Mahajangasuchus insignis* Buckley & Brochu, 1999
DATA FROM: Buckley & Brochu (1999), Turner & Buckley (2008).
LOCALITY: 1km SW Berivotra Village, SW Mahajanga, NW Madagascar.
FORMATION: Maevarano Formation. Mahajanga Basin.
AGE: Campanian–Maastrichtian, Upper Cretaceous.

NEOSUCHIA: ATOPOSAURIDAE (2 OTUs)
(25) *Alligatorium meyeri* Gervais, 1871
DATA FROM: photographs of the holotype provided by Jon Tennant.
LOCALITY: Cerin, France.
FORMATION: Cerin Lagerstätte.
AGE: upper Kimmeridgian, Upper Jurassic.

(26) *Theriosuchus pusillus* Owen, 1878
DATA FROM: NHMUK PV OR 48216 (lectotype), NHMUK PV OR 48330 (paratype), NHMUK PV OR 48262; Tennant *et al*. (2016).
LOCALITY: Durlston Bay, Swanage, Dorset County, Jurassic Coast, S-SW England, UK.
FORMATION: “Beccles’ residuary marls” (beds 83–93; Clements, 1993), Worbarrow Tout Member (sensu Westhead & Mather, 1996), Lulworth Formation, Purbeck Limestone Group.
AGE: Berriasian, Lower Cretaceous.

NEOSUCHIA: GONIOPHOLIDIDAE (8 OTUs)
(27) *Eutretauranosuchus delfsi* Mook, 1967
DATA FROM: CM 8028 (holotype); Smith *et al*. (2010).
LOCALITY: Canon City, Colorado, USA.
FORMATION: Morrison Formation. Morrison Basin.
AGE: Kimmeridgian, Upper Jurassic.

(28) *Amphicotylus stovalli* (Mook, 1964)
DATA FROM: CMC VP7798 (cast).
LOCALITY: V97, Cimarron County, Oklahoma, USA.
FORMATION: Morrison Formation.
AGE: ?Kimmeridgian, Upper Jurassic.

(29) *Goniopholis baryglyphaeus* Schwarz, 2002
DATA FROM: Schwarz (2002).
LOCALITY: Guimarota coal mine, Leiria, Portugal.

FORMATION: Lower lignite coal layer (`Fundschichten'), `Guimarota Strata', Alcobaca Formation.
AGE: Kimmeridgian, Upper Jurassic.

(30) *Goniopholis kiplingi* Andrade *et al*., 2011.
DATA FROM: DORCM 12154 (holotype); Andrade *et al*. (2011).
LOCALITY: Durlston Bay, Swanage, Dorset County, Jurassic Coast, SSW England, UK.
FORMATION: Bed 129b (Clements 1993), Intemarine beds (sensu Wimbledon, 1995), Stair Hole Member (sensu Westhead & Mather 1996), Durlston Formation, Purbeck Limestone Group.
AGE: Berriasian, Lower Cretaceous.

(31) *Goniopholis simus* Owen, 1878
DATA FROM: NHMUK PV OR 41098 (type), NHMUK PV R 5814.
LOCALITIES: Swanage, Dorset County, Jurassic Coast, S-SW England; further referred materials from Schaumburg-Lippe Region, NW Germany.
FORMATIONS: Purbeck Limestone Group (UK) and Obernkirchen Sandstone, Buckeburg Member (Germany).
AGE: Berriasian, Lower Cretaceous.

(32) *Anteophthalmosuchus hooleyi* Salisbury & Naish, 2011
DATA FROM: NHMUK PV R 3876 (holotype); Salisbury & Naish (2011).
LOCALITY: near the “Tie Pits”, Atherfield Point, Isle of Wight, UK.
FORMATION: Shepherd’s Chine Member, Vectis Formation, Wealden Group.
AGE: Barremian to early Aptian, Lower Cretaceous.

(33) *Anteophthalmosuchus epikrator* Ristevski *et al*., 2018.
DATA FROM: IWCMS 2001.446, IWCMS 2005.127; Martin *et al*. (2016).
LOCALITY: Hanover Point, Isle of Wight, UK.
FORMATION: upper part of Wessex Formation, Wealden Group.
AGE: Barremian, Lower Cretaceous.

TETHYSUCHIA: PHOLIDOSAURIDAE (11 OTUs)
(34) *Elosuchus cherifensis* (Lavocat, 1955)
DATA FROM: MNHN.F MRS 340, MNHN Escuillé collection; de Lapparent de Broin (2002), Meunier & Larsson (2016).
LOCALITY: Hamadas, Morocco.
FORMATION: Kem Kem beds, Ifezouanae and Aoufous Formations.
AGE: Cenomanian, Upper Cretaceous.

(35) *Elosuchus broinae* Meunier & Larsson, 2016
DATA FROM: MNHN.F SAM 129 (holotype), de Lapparent de Broin (2002); Meunier & Larsson (2016).
LOCALITY: Gara Samani, Algeria.
FORMATION: unnamed formation.
AGE: upper Albian, Lower Cretaceous.

(36) *Vectisuchus leptognathus* Buffetaut & Hutt, 1980
DATA FROM: SMNS 50984 (holotype).
LOCALITY: Isle of Wight, UK.
FORMATION: Vectis Formation, Wealden Group. Wessex Sub-basin.
AGE: Barremian–?early Aptian, Lower Cretaceous.

(37) *Pholidosaurus schaumburgensis* von Meyer, 1841
DATA FROM: casts of the Koken (1887) specimens (including MB.R.1965, MB.R.1966, MB.R.1970.304); the natural external and internal moulds of Bückeburg specimens (MB.R.2025.1, two MB.R.unumbered specimens); Koken, 1887.
LOCALITY: quarry near Harrel im Furstentum, Schaumburg-Lippe Region, NW Germany.
FORMATION: Obernkirchen Member, Bückeburg Formation.
AGE: Berriasian, Lower Cretaceous.
OBSERVATION: Only specimens from the Bückeburg Formation are used to score this OTU.

(38) *Pholidosaurus* sp. (Charente)
DATA FROM: Martin *et al*. (2016b).
LOCALITY: Cherves-de-Cognac, Carrière de Champblanc, Charente Department, SW France.
FORMATION: Horizon C36.
AGE: Berriasian, Lower Cretaceous.

(39) *Meridiosaurus vallisparadisi* Fortier *et al*., 2011
DATA FROM: Fortier *et al*. (2011).
LOCALITY: Valle Edén locality, near Tacuarembó city, Uruguay.
FORMATION: fluviolacustrine sandstone facies of the Batoví Member, Tacuarembó Formation
AGE: ?Kimmeridgian-Tithonian, Upper Jurassic.

(40) *Chalawan thailandicus* (Buffetaut & Ingavat, 1980)
DATA FROM: Buffetaut & Ingavat (1980), Martin *et al*. (2014).
LOCALITIES: Nong Bua Lam Phu (type locality) and Kham Phok, NE Thailand.
FORMATION: upper part of Phu Kradung Formation, Khorat Group. Khorat Basin.
AGE: Early Cretaceous.

(41) *Sarcosuchus hartti* (Marsh, 1896) [fragmentary taxon]
DATA FROM: NHMUK PV R 3423; Buffetaut & Taquet (1977).
LOCALITY: outcrop in the vicinity of Setubal, Bahia State, NE Brazil.
FORMATION: unclear.
AGE: Lower Cretaceous.
OBSERVATION: This OTU is scored solely for the lower jaw referred to *S. hartti* by Buffetaut & Taquet (1977).

(42) *Sarcosuchus imperator* de Broin & Taquet, 1966
DATA FROM: MNHN.F GDF 662; de Broin & Taquet (1966), Buffetaut & Taquet (1977), Sereno *et al.* (2001).
LOCALITY: outcrop in the vicinities of the Gadoufaoua, Agadez Province, Niger.
FORMATION: Elrhaz Formation. Tegama Basin.
AGE: Aptian, Lower Cretaceous.

(43) cf. *Terminonaris robusta* Mook, 1934
DATA FROM: Wu *et al*. (2001b), Larsson & Sues (2007).
LOCALITY: SMNH locality 63E04-001, approximately 5km east of Highway 23, the southern bank of the Carrot River, southwest of the Pasquia Hills, Saskatchewan, Canada.
FORMATION: Keld Member, Favel Formation.
AGE: upper Cenomanian? to lower Turonian, Upper Cretaceous.
OBSERVATION: This OTU is based solely on the Canadian material referred to *T. robusta*.

(44) *Oceanosuchus boecensis* Hua *et al*., 2007
DATA FROM: Hua *et al*. (2007), Lepage *et al*. (2008).
LOCALITY: La Boëce, near Mortagne-au-Perche, Orne, Vasse-Normandie, France.
FORMATION: base of hard-ground Coulimer 2.
AGE: lower Cenomanian, Upper Cretaceous.

TETHYSUCHIA: BASAL DYROSAUROIDEA (2 OTUs)

(45) *Pholidosaurus purbeckensis* (Mansel-Pleydell, 1888)
DATA FROM: DORCM G.27, DORCM G.97 (holotype), NHMUK PV OR 28432, NHMUK PV R 3414, NHMUK PV R 3956, NHMUK PV R 36721.
LOCALITY: type locality unclear, thought to be Isle of Purbeck, UK.
FORMATION: Purbeck Formation, Purbeck Limestone Group.
AGE: Berriasian, Lower Cretaceous.

(46) *Fortignathus felixi* Young *et al*., 2016 [fragmentary taxon]
DATA FROM: MNHN.F INA 21, MNHN.F INA 22, MNHN.F INA 25 (holotype).
LOCALITY: West of In Abangharit, Agadez District, Niger.
FORMATION: Echkar Formation, Tegma Series.
AGE: upper Albian to lower Cenomanian, 'mid' Cretaceous.

TETHYSUCHIA: DYROSAURIDAE (15 OTUs)

(47) *Acherontisuchus guajiraensis* Hastings *et al*., 2011 [fragmentary taxon]
DATA FROM: UF/IGM 34 (holotype), UF/IGM 35, UF/IGM 36, UF/IGM 37, UF/IGM 38 & UF/IGM 39; Hastings *et al*. (2011).
LOCALITY: below Coal Seam 85 in the La Puente Pit, Cerrejón coal mine, Guajira Department, north-eastern Colombia.
FORMATION: Cerrejón Formation.

AGE: middle–late Paleocene, Palaeogene.

(48) *Anthracosuchus balrogus* Hastings *et al*., 2015
DATA FROM: UF/IGM 67 (holotype), UF/IGM 68 (paratype), UF/IGM 69 & UF/IGM 70; Hastings *et al*. (2015).
LOCALITY: clay layer below Coal Seam 90 in the La Puente Pit, Cerrejón coal mine, Guajira Department, north-eastern Colombia.
FORMATION: Cerrejón Formation.
AGE: middle–late Paleocene, Palaeogene.

(49) *Arambourgisuchus khouribgaensis* Jouve *et al*., 2005a.
DATA FROM: Jouve *et al*. (2005a).
LOCALITY: Phosphate mine in 'Sidi Chenane' area, in NE part of Ouled Aboun Basin, Morocco.
FORMATION: couche (= bed/layer) 2a.
AGE: Thanetian, Paleocene, Palaeogene.

(50) *Atlantosuchus coupatezi* Buffetaut, 1979
DATA FROM: Jouve *et al*. (2008).
LOCALITY: 'Sidi Chenane' area, in NE part of Ouled Aboun Basin, Morocco.
FORMATION: not given.
AGE: Danian, Paleocene, Palaeogene.

(51) *Cerrejonisuchus improcerus* Hastings *et al*., 2010
DATA FROM: UF/IGM 29 (holotype), UF/IGM 30, UF/IGM 31 & UF/IGM 32; Hastings *et al*. (2010).
LOCALITY: clay layer below Coal Seam 90 in the La Puente Pit, Cerrejón coal mine, Guajira Department, north-eastern Colombia.
FORMATION: Cerrejón Formation.
AGE: middle–late Paleocene, Palaeogene.

(52) *Chenanisuchus lateroculi* Jouve *et al*., 2005b
DATA FROM: Jouve *et al*. (2005b).
LOCALITY: 'Sidi Chenane' area, in NE part of Ouled Aboun Basin, Morocco.
FORMATION: couche (= bed/layer) 2a.
AGE: Thanetian, Paleocene, Palaeogene.

(53) *Congosaurus bequaerti* Dollo, 1914
DATA FROM: Jouve & Schwarz (2004), Schwarz *et al.* (2006), Schwarz-Wings *et al.* (2009).
LOCALITY: Cacongo, Cabinda Province, Angola.
FORMATION: Bed no. 8.
AGE: Danian, Paleocene, Palaeogene.

(54) *Dyrosaurus maghribensis* Jouve *et al*., 2006
DATA FROM: Jouve *et al.* (2006).

LOCALITY: phosphate mine of Mera el Arech, in Oulad Abdoun Basin, Morocco.
FORMATION: couche (= bed/layer) 1.
AGE: Ypresian, lower Eocene, Palaeogene.

(55) *Dyrosaurus phosphaticus* (Thomas, 1893)
DATA FROM: MNHN.F ALG 1, MNHN.F ALG 2; Jouve (2005).
LOCALITIES: north of Djebel Teldj, near Metlaoui, Tunisia and Tébessa, north-east Algeria.
FORMATION: "phosphate layer" (Tunisia).
AGE: Ypresian, lower Eocene, Palaeogene.

(56) *Guarinisuchus munizi* Barbosa *et al*., 2008
DATA FROM: Barbosa *et al.* (2008).
LOCALITY: Poty Quarry, Paulista, NE of Pernambuco State, Brazil.
FORMATION: Maria Farinha Formation. Paraiba Basin.
AGE: upper Danian, Lower Paleocene, Palaeogene.

(57) *Hyposaurus rogersii* Owen, 1849
DATA FROM: Troxell (1925), Denton *et al*. (1997).
LOCALITIES: Numerous, including: Inversand Company Marl Pit, Gloucester County, New Jersey, USA; Santee rediversion canal, St. Stephen, Berkeley County, South Carolina, USA.
FORMATION: Hornerstown Formation (NJ), Williamsburg Formation (SC).
AGE: Maastrichtian, Upper Cretaceous (NJ), upper Paleocene, Palaeogene (SC).

(58) *Phosphatosaurus gavialoides* Bergounioux, 1955
DATA FROM: Buffetaut (1978), Hill *et al*. (2008).
LOCALITY: near Metlaoui, Tunisia and 'Mali-20', south of Tamaguélet, Tilemsi valley region, Mali.
FORMATION: "phosphate layer" (Tunisia) and unnamed formation in Taoudeni Basin (Mali).
AGE: Ypresian, lower Eocene, Palaeogene.

(59) *Rhabdognathus keiniensis* Jouve, 2007.
DATA FROM: Jouve (2007).
LOCALITY: Cheit Keini and In Farghas, Tilemsi valley region, Mali.
FORMATION: unnamed formation in Taoudeni Basin.
AGE: Paleocene, Palaeogene.

(60) *Rhabdognathus aslerensis* Jouve, 2007
DATA FROM: Brochu *et al*. (2002), Jouve (2007).
LOCALITY: 'Mali-5', near Asler, north-west of Tamaguélet, Tilemsi valley region, Mali.
FORMATION: unnamed formation in Taoudeni Basin.
AGE: Maastrichtian or Paleocene.

(61) *Sabinosuchus coahuiliensis* Shiller *et al*., 2016 [fragmentary taxon]
DATA FROM: Shiller *et al*. (2016).
LOCALITY: El Rancho Soledad, Coahuila, Mexico.
FORMATION: Escondido Formation.
AGE: Maastrichtian, Upper Cretaceous.

(62) *Sokotosuchus ianwilsoni* Halstead, 1975
DATA FROM: Buffetaut (1979).
LOCALITY: Sokoto area, NW Nigeria.
FORMATION: Dukamaje Formation.
AGE: Maastrichtian, Upper Cretaceous.

NEOSUCHIA: BERNISSARTIIDAE (2 OTUs)
(63) *Bernissartia fagesii* Dollo, 1883
DATA FROM: Norell & Clark (1990).
LOCALITY: Sainte-Barbe coal mine, Bernissart, Belgium.
FORMATION: Sainte-Barbe Clays Formation.
AGE: Berriasian–Barremian, Lower Cretaceous.

(64) *Koumpiodontosuchus aprosdokiti* Sweetman *et al*., 2015
DATA FROM: IWCMS 2012.203 and IWCMS 2012.204 (holotype), Sweetman *et al*. (2015).
LOCALITY: The foreshore near Yaverland, SE coast of Isle of Wight, UK.
FORMATION: from one of the plant debris beds occurring between beds 26 and 38, Wessex Formation.
AGE: Barremian, Lower Cretaceous.

NEOSUCHIA: SUSISUCHIDAE (2 OTUs)
(65) *Susisuchus anatoceps* Salisbury *et al*., 2003
DATA FROM: SMNK PAL3804 (holotype); Salisbury *et al.* (2003, 2006).
LOCALITY: Araripe Plateau, NE Brazil.
FORMATION: Crato Member, Santana Formation. Araripe Basin.
AGE: Aptian–Albian, Lower Cretaceous.

(66) *Isisfordia duncani* Salisbury *et al*., 2006
DATA FROM: Salisbury *et al.* (2006; QM-F-36211, QM-F-44320).
LOCALITY: outcrop near Isisford, Queensland, Australia.
FORMATION: Winton Formation.
AGE: Albian–Cenomanian, 'mid' Cretaceous.

EUSUCHIA: HYLAEOCHAMPSIDAE *SENSU LATO* (3 OTUs)
(67) *Iharkutosuchus makadii* Ősi *et al*., 2007
DATA FROM: MTM 2006.52.1 (holotype), MTM 2006.53.1, MTM PAL 2013.51.1, MTM PAL 2013.58.1; Ősi *et al*. (2007), Ősi (2008), Ősi (2014).
LOCALITY: Iharkút, Bakony Mountains, western Hungary.
FORMATION: Csehbánya Formation.
AGE: Santonian, Upper Cretaceous.

(68) *Pachycheilosuchus trinquei* Rogers, 2003
DATA FROM: Rogers (2003); osteoderms re-scored based on Buscalioni *et al*. (2011).
LOCALITY: SMU locality 331, Erath County, Texas, USA.
FORMATION: Glen Rose Formation.
AGE: Albian, Lower Cretaceous.

(69) *Pietraroiasuchus ormezzanoi* Buscalioni *et al*., 2011
DATA FROM: Buscalioni *et al*. (2011).
LOCALITY: locality of 'Civita di Pietraroia', Mt Matese, southern Italy.
FORMATION: 'Civita di Pietraroia Cave'.
AGE: lower Albian, Lower Cretaceous.

EUSUCHIA: CROCODYLIA (4 OTUs)
(70) *Gavialis gangeticus* (Gmelin, 1879)
DATA FROM: comparative collection held in the Palaeontology and Zoology departments of NHMUK.
DISTRIBUTION: river systems of Brahmaputra, Indus, Ganges, Mahanadi; Burma, Buthan, India, Nepal and Pakistan.
AGE: extant – Holocene, Quaternary.

(71) *Crocodylus niloticus* (Laurenti, 1768)
DATA FROM: comparative collection held in the Palaeontology and Zoology departments of NHMUK; and in the Life Sciences Faculty, Ohio University.
DISTRIBUTION: river systems of several African countries, especially the Nile River, Egypt.
AGE: extant – Holocene, Quaternary.

(72) *Crocodylus porosus* (Schneider, 1801)
DATA FROM: comparative collection held in the Palaeontology and Zoology departments of NHMUK; and in the Life Sciences Faculty, Ohio University.
DISTRIBUTION: freshwater to brackish areas of several countries, from SE Asia to Australia.
AGE: extant – Holocene, Quaternary.

(73) *Alligator mississippiensis* (Daudin, 1802)
DATA FROM: NHMUK ZD 290, NHMUK ZD 1973-2-21-2, NHMUK ZD 1974-3010, NHMUK ZD 1975-1424, NHMUK ZD II-1-I.
DISTRIBUTION: swamp to low-energy river systems of SE USA, most noticeably in Florida.
AGE: extant – Holocene, Quaternary.

THALATTOSUCHIA: TELEOSAUROIDEA (27 OTUs)
(74) *Aeolodon priscus* (von Sömmerring, 1814)
DATA FROM: NMHUK PV R 1086 (holotype), MNHN.F CNJ 78a.
LOCALITIES: Daiting, S Germany, and Canjuers, Var, France.

FORMATION: Mörnsheim Formation (type locality) and Canjuers conservation Lagerstätte.
AGE: lower Tithonian, Upper Jurassic.

(75) *Sericodon jugleri* von Meyer, 1845
DATA FROM: BSY006-348, BSY007-134, BSY008-622, SCR010-312, SCR010-1184, SCR011-2460, SCR011-406, TCH005-151 TCH007-215, VTT006-171 (see Schaefer, Püntener & Billon-Bruyat (2018)).
LOCALITY: Courtedoux-Bois de Sylleux, Courtedoux-sur Combe Ronde, Courtedoux-Tchâfouè and Courtedoux-Vâ Tche Tchâ, northwestern Switzerland; Hannover, Germany.
FORMATION: Reuchenette Formation
AGE: Late Kimmeridgian to Early Tithonian, Upper Jurassic.

(76) *Machimosaurus buffetauti* Young *et al*., 2015
DATA FROM: SMNS 91415 (holotype); Young *et al*. (2014).
LOCALITY: Am Hörnle Quarry, Neuffen, Baden-Württemberg, Germany.
FORMATION: Lacunosamergel Formation.
AGE: *Ataxioceras hypselocyclum* Sub-Mediterranean ammonite Zone (=Weißer Jura gamma 2), lower Kimmeridgian, Upper Jurassic.
OBSERVATION: The correct nominal authority is the short taxonomic note Young *et al*., 2015 not Young *et al*. 2014 (where the new taxon was described).

(77) *Machimosaurus hugii* (von Meyer, 1837) emend. von Meyer, 1838
DATA FROM: MG-8730-1, Young *et al*. (2014).
LOCALITIES: Kreuzen Quarry at St. Verena, near Solothurn, Canton Solothurn, Switzerland (lectotype locality) and Guimarota coal mine, Leiria, NW Portugal.
FORMATION: Solothurn Turtle Limestone, Reuchenette Formation (lectotype locality) and Guimarota Strata, Alcobaça Formation.
AGE: Kimmeridgian, Upper Jurassic.

(78) *Machimosaurus mosae* Sauvage & Liénard, 1879
DATA FROM: IRSNB (cast of neotype), Hua (1999), Young *et al*. (2014).
LOCALITY: beach near Ambleteuse, Boulonnais, Département du Pas-de-Calais, Nord Pas-de-Calais, France (neotype locality).
FORMATION: Argiles de Châtillon Formation (neotype locality).
AGE: From either the *Aulacostephanus autissiodorensis* Sub-Boreal ammonite Zone, uppermost Kimmeridgian, or the *Gravesia gigas*/*Pectinaties elegans* Sub-Boreal ammonite Zone, lowermost Tithonian; Upper Jurassic (neotype locality).

(79) *Machimosaurus rex* Fanti *et al*., 2016
DATA FROM: ONM-NG-1 (holotype), Fanti *et al*. (2016).
LOCALITY: Touil el Mhahir, Tataouine Governorate, Tunisia.
FORMATION: Douiret Sand Member, Douiret Formation.
AGE: Hauterivian, Lower Cretaceous.

(80) *Mycterosuchus nasutus* (Andrews, 1909) Andrews, 1913
DATA FROM: NHMUK PV R 3577 (holotype), CAMSM J.1420, Andrews (1913).
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(81) Chinese teleosauroid skull referred to *Peipehsuchus teleorhinus* by Li (1993)
DATA FROM: IVPP V 10098.
LOCALITY: Daxian, Szechuan, China.
FORMATION: Ziliujing Formation.
AGE: Bathonian, Lower Jurassic.

(82) *Platysuchus multiscrobiculatus* (Berckhemer, 1929) Westphal, 1961
DATA FROM: SMNS 9930 (holotype), MNHNL TU895.
LOCALITIES: Holzmaden, Baden-Württemberg, Germany; Foetz, Luxembourg.
FORMATION: Posidonia Shale Formation and *Harpoceras serpentinum* ammonite
Zone ('*schistes bitumineux*').
AGE: lower Toarcian, Lower Jurassic.

(83) *Clovesuurdameredeor stephani* (Hulke, 1877)
DATA FROM: NHMUK PV OR 49126 (holotype).
LOCALITY: Closworth, Dorsetshire, UK.
FORMATION: Cornbrash Formation, Great Oolite Group.
AGE: Bathonian, lower Jurassic.

(84) *Macrospondylus bollensis* von Jäeger, 1828
DATA FROM: GPIT-RE-9427, MMG BwJ 595 (holotype), MMG BwJ 689, NHMUK PV R 324, NHMUK PV R 756, NHMUK PV R 1088, NHMUK PV R 5703, NHMUK PV OR 14436, NHMUK PV OR 14438, NHMW-1882-0026-4082, SMNS 849, SMNS 9427, SMNS 9428, SMNS 17484, SMNS 20280, SMNS 20283, SMNS 53422, unnumbered OUMNH partial skull.
LOCALITIES: Baden-Württemberg, Germany; Yorkshire, UK; Sanem, Luxembourg.
FORMATION: Posidonia Shale Formation (Germany), Whitby Mudstone Formation (UK), *Harpoceras serpentinum* ammonite Zone ('*schistes bitumineux*'; Luxembourg).
AGE: lower Toarcian, Lower Jurassic.

(85) *Mystriosaurus laurillardi* Kaup, 1834
DATA FROM: HLMD V946-948 (holotype).
REFERRED SPECIMEN: NHMUK PV OR 14781.

LOCALITIES: Altdorf, Germany (type); Whitby, Yorkshire, UK.
FORMATIONS: Posidonia Shale Formation (type); Mulgrave Shale Member, Whitby Mudstone Formation, Lias Group.
AGE: *Harpoceras serpentinum* Sub-Boreal ammonite Zone, lower Toarcian, Lower Jurassic.

(86) *Neosteneosaurus edwardsi* (Eudes-Deslongchamps, 1868a)
DATA FROM: NHMUK PV R 2074, NHMUK PV R 2865, NHMUK PV R 3701, PETMG R175, PETMG R178, Andrews (1913).
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(87) *Plagiophthalmosuchus gracilirostris* (Westphal, 1961)
DATA FROM: NHMUK PV OR 14792 (holotype), NHMUK PV OR 15500 (paratype), MNHNL TU515.
LOCALITY: Whitby, Yorkshire, UK; Dudelange-Bettembourg, Luxembourg.
FORMATION: Alum Shale Member, Whitby Mudstone Formation, Lias Group; *Harpoceras serpentinum* ammonite Zone ('*schistes bitumineux*').
AGE: *Hildoceras bifrons* Sub-Boreal ammonite Zone, lower Toarcian, Lower Jurassic.

(88) *Seldsienean megistorhynchus* (Eudes-Deslongchamps, 1866)
DATA FROM: OUMNH J.1414, Eudes-Deslongchamps (1866, 1867-69).
LOCALITY: Enslow Bridge, Oxfordshire, UK.
FORMATION: Great Oolite Group.
AGE: Bathonian, Middle Jurassic.

(89) *Yvridiosuchus boutilieri* (Eudes-Deslongchamps, 1868c)
DATA FROM: OUMNH J.1401 (neotype), OUMNH J.29850, OUMNH J.1403.
LOCALITY: Enslow Bridge, Oxfordshire, UK (neotype).
FORMATION: Great Oolite Group.
AGE: Bathonian, Middle Jurassic.

(90) *Deslongchampsina larteti* (Eudes-Deslongchamps, 1866)
DATA FROM: OUMNH J.29851 (neotype), Eudes-Deslongchamps (1867-69).
LOCALITY: Enslow Bridge, Oxfordshire, UK (neotype).
FORMATION: Great Oolite Group.
AGE: Bathonian, Middle Jurassic.

(91) '*Steneosaurus*' *rostromajor* (Cuvier, 1824) Geoffory Saint-Hilaire, 1825
DATA FROM: MNHN RJN.134c-d (type specimen of '*Steneosaurus*').
LOCALITY: Vaches Noires, Calvados, France.
FORMATION: Possibly Marnes de Villiers Formation.
AGE: Callovian/Oxfordian, Middle Jurassic.

(92) *Charitomenosuchus leedsi* (Andrews, 1909)
DATA FROM: NHMUK PV R 2619, NHMUK PV R 3320 (holotype), NHMUK PV R 3806.
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(93) *Proexochokefalos heberti* (Morel de Glasville, 1876)
DATA FROM: MNHN.F 13.1890 (holotype).
LOCALITY: Villers-sur-mer, Calvados, France.
FORMATION: Marnes de Dives Formation.
AGE: upper Callovian, Middle Jurassic.

(94) *Proexochokefalos cf. bouchardi* (Sauvage, 1872)
DATA FROM: Sauvage (1872); Buffetaut & Makinsky (1984); Lepage et al. (2008); SCR010-374 (see Schaefer, Püntener & Billon-Bruyat (2018)).
LOCALITIES: Villerville, Calvados, France; Courtedoux-sur Combe Ronde, northwestern Switzerland.
FORMATIONS: “Calcaire de Caen”; Reuchenette Formation.
AGE: Kimmeridgian, Upper Jurassic.

(95) *Andrianavoay baroni* (Newton, 1893)
DATA FROM: NHMUK PV R 1999 (holotype).
LOCALITY: Andranosamonta, north-western Madagascar.
FORMATION: Unknown.
AGE: Bathonian, Middle Jurassic.

(96) *Lemmysuchus obtusidens* (Andrews, 1909) Johnson *et al*., 2017
DATA FROM: NHMUK PV R 3168 (holotype), LPP.M.21, NOTNH FS3361, PETMG R39.
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(97) *Teleosaurus cadomensis* (Lamouroux, 1820)
DATA FROM: MNHN.F AC 8746, MNHN.F RJN 464, NHMUK PV OR 119, NHMUK PV OR 32588, NHMUK PV OR 32657, NHMUK PV OR 32680, NHMUK PV OR 33124, casts: NHMUK PV R 880 and NHMUK PV R 880a; Eudes-Deslongchamps (1867-69); Jouve (2009).
LOCALITY: Allemagne, 3km south of Caen, Calvados, Normandy, France.
FORMATION: “Calcaire de Caen”.
AGE: Bathonian, Middle Jurassic.

(98) *Bathysuchus megarhinus* (Hulke, 1871) Foffa et al., 2019

DATA FROM: NHMUK PV OR 43086 (holotype), DORCM G.05067i-v, LPP unnumbered specimen, Vignaud (1995).
LOCALITY: Kimmeridge, Dorset, UK.
FORMATION: Dorset succession, lower Kimmeridge Clay Formation, Ancholme Group.
AGE: *Aulacostephanus autissiodorensis* Sub-Boreal ammonite Zone, upper Kimmeridgian, Upper Jurassic.

(99) *Indosinosuchus potamosiamensis* (Martin et al., 2019)
DATA FROM: PRC-11.
LOCALITY: Pho Noi, Phu Phan range, Kham Muang District, Kalasin Province, north-eastern Thailand.
FORMATION: lower part of the Phu Kradung Formation, Khorat Group.
AGE: Late Jurassic.

(100) *Indosinosuchus* sp.
DATA FROM: PRC-239.
LOCALITY: Pho Noi, Phu Phan range, Kham Muang District, Kalasin Province, north-eastern Thailand.
FORMATION: lower part of the Phu Kradung Formation, Khorat Group.
AGE: Late Jurassic.

THALATTOSUCHIA: BASAL METRIORHYNCHOIDAE (7 OTUs)
(101) *Eoneustes gaudryi* (Collot, 1905) Young *et al*., 2010
DATA FROM: NHMUK PV R 3353 (holotype).
LOCALITY: Saint-Seine-l'Abbaye, Département du Cote d'Or, Bourgogne, France.
FORMATION: “Calcaires blancs jaunâtres des de Bourgogne”.
AGE: lower Bathonian, Middle Jurassic.

(102) *Magyarosuchus fitosi* Ősi *et al*., 2018
DATA FROM: MTM V.97 (holotype).
LOCALITY: eastern Gerecse Mountains, Hungary.
FORMATION: Bed 13, uppermost Kisgerecse Marl Formation.
AGE: *Grammoceras striatulum* ammonite Subzone, *Grammoceras thouarense* ammonite Zone, upper Toarcian, Early Jurassic.

(103) Metriorhynchoidea indeterminate (Chile) [fragmentary taxon]
DATA FROM: Gasparini *et al*. (2000).
LOCALITY: Quebrada La Iglesia, Copiapo, Central-east Chile.
FORMATION: upper part of the Lautaro Formation.
AGE: lower Bajocian, Middle Jurassic.

(104) *Zoneait nargorum* Wilberg, 2015a
DATA FROM: Wilberg (2015a).
LOCALITY: near Suplee, Oregon, USA.
FORMATION: Weberg Member, Snow-shoe Formation.
AGE: uppermost Aalenian or lowermost Bajocian, Middle Jurassic.

(105) *Peipehsuchus teleorhinus* Young, 1948 [fragmentary taxon]
DATA FROM: IVPP RV 48001.
LOCALITY: Beipei, Szechuan, China.
FORMATION: Ziliujing Formation.
AGE: Lower Jurassic.
OBSERVATION: This OTU is solely based on the holotype, with the skull referred to *Peipehsuchus teleorhinus* treated as a separate OTU.

(106) *Pelagosaurus typus* Bronn, 1841
DATA FROM: BRLSI M.1415, BRLSI M.1416, BRLSI M.1420, MNHN.F RJN 463, MTM V.52.2516, NHMUK PV OR 19735, NHMUK PV OR 32599, SMNS 8666, SMNS 17758, SMNS 50374, SMNS 80066; Pierce & Benton (2006).
LOCALITIES: Numerous, including: Amaye-sur-Orne, Caen, and Curcy, France; Nabern near Kirchheim, S Germany; Holzmaden, Bad Boll, Ohmden and Ohmdenhausen, Swabian Jura, S Germany; Ilminster, Somerset, UK; Whitby, Yorkshire, England.
FORMATIONS: Numerous, including: Posidonia Shale Formation (Germany) and Whitby Mudstone Formation (UK).
AGE: lower Toarcian, Lower Jurassic.
OBSERVATION: this OTU includes *P. moorei* as a subjective junior synonym of *P. typus*, following Pierce & Benton (2006).

(107) *Teleidosaurus calvadosii* (Eudes-Deslongchamps, 1866)
DATA FROM: NHMUK PV R 2619 (plastoholotype); Eudes-Deslongchamps (1867-69).
LOCALITY: Allemagne, 3km south of Caen, Calvados, Normandy, France.
FORMATION: “Calcaire de Caen”.
AGE: Bathonian, Middle Jurassic.

THALATTOSUCHIA: METRIORHYNCHIDAE: METRIORHYNCHINAE (21 OTUs)

(108) '*Dakosaurus*' *lissocephalus* Seeley, 1869
DATA FROM: CAMSM J29419 (holotype).
LOCALITY: Ely, Cambridgeshire, UK
FORMATION: lower Kimmeridge Clay Formation, Ancholme Group.
AGE: upper Kimmeridgian, Upper Jurassic.

(109) *Cricosaurus araucanensis* (Gasparini & Dellapé, 1976) Young & Andrade, 2009
DATA FROM: MLP-72-IV-7-1 (holotype), MLP-72-IV-7-2; Gasparini & Dellapé (1976), Fernández & Gasparini (2000, 2008), Fernández & Herrera (2009), Herrera *et al.* (2009).
LOCALITY: Argentina.
FORMATION: Vaca Muerta Formation, Mendoza Group. Neuquén Basin.
AGE: lower Tithonian, Upper Jurassic.

(110) NKMB-P-Watt14/274
DATA FROM: NKMB-P-Watt14/274.
LOCALITY: Wattendorf quarry, Wattendorf, Bayern, Germany.
FORMATIONS: Wattendorf Member, Torleite Formation.
AGE: *Aulacostephanus eudoxus* Tethys ammonite Zone, upper Kimmeridgian, Upper Jurassic.

(111) *Cricosaurus elegans* (Wagner, 1852) Wagner, 1858
DATA FROM: BSPG AS I 504.
LOCALITY: Daiting, near Monheim, Bayern, Germany.
FORMATIONS: Mörnsheim Formation.
AGE: *Hybonoticeras hybonotum* Tethys ammonite Zone, lower Tithonian, Upper Jurassic.

(112) *Cricosaurus lithographicus* Herrera *et al*., 2013
DATA FROM: Herrera *et al*. (2013).
LOCALITY: El Ministerio Quarry, Los Catutos Area, Zapala Department, Neuquén Province, Argentina.
FORMATION: Los Catutos Member, Vaca Muerta Formation, Mendoza Group. Neuquén Basin.
AGE: upper lower or middle upper Tithonian, Upper Jurassic.

(113) '*Cricosaurus*' *macrospondylus* (Koken, 1883) Young & Andrade, 2009
DATA FROM: Hua *et al*. (2000).
LOCALITY: Barret-le-Bas, Département du Hautes-Alpes, Provence-Alpes-Côte d'Azur, France.
FORMATION: not given.
AGE: *Busnardoites campylotoxus* ammonite Zone, lower Valanginian, Lower Cretaceous.
OBSERVATION: This OTU is solely based on the French referred specimen.

(114) '*Cricosaurus*' *saltillensis* (Buchy *et al*., 2006) Young & Andrade, 2009
DATA FROM: Buchy *et al*. (2006); Buchy *et al*. (2013).
LOCALITY: Sierra de Buñuelas, near Gomez Farías, State of Coahuila, Mexico.
FORMATION: La Caja Formation.
AGE: lower Tithonian, Upper Jurassic.

(115) *Cricosaurus schroederi* (Kuhn, 1936) Young & Andrade, 2009
DATA FROM: Karl *et al*. (2006b); photographs of the holotype provided by Nils Knötschke.
LOCALITY: Sachsenhagen, Lower Saxony, Germany.
FORMATION: '*Platylenticeras* beds'.
AGE: lower Valanginian, Lower Cretaceous.

(116) *Cricosaurus suevicus* (Fraas, 1901) Young & Andrade, 2009
DATA FROM: SMNS 9808 (lectotype), SMNS 90513; Fraas (1901, 1902).
LOCALITY: Nusplingen, Zollernalbkreis, Baden-Württemberg, Germany.

FORMATION: Nusplingen Plattenkalk.
AGE: *Hybonoticeras beckeri* Tethys ammonite Zone (= Malm Zeta 1), upper Kimmeridgian, Upper Jurassic.

(117) *Cricosaurus* sp. (Cuba)
DATA FROM: Gasparini & Iturralde-Vinent (2001).
LOCALITY: Viñales Valley, western Cuba.
FORMATION: Jagua Vieja Member, Jagua Vieja Formation.
AGE: middle or upper Oxfordian, Upper Jurassic.

(118) *Cricosaurus* sp. (Painten taxon)
DATA FROM: BMMS-BK 1-2.
LOCALITY: Rygol quarry, Painten, Bayern, Germany.
FORMATION: Arnstorf Member, Torleite Formation.
AGE: *Hybonoticeras beckeri* Tethys ammonite Zone (= Malm Zeta 1), upper Kimmeridgian, Upper Jurassic.

(119) *Cricosaurus vignaudi* (Frey *et al*., 2002) Young & Andrade, 2009
DATA FROM: Frey *et al*. (2002).
LOCALITY: Mazatepec, State of Puebla, Mexico.
FORMATION: La Pimienta Formation.
AGE: 'middle' Tithonian, Upper Jurassic.

(120) *Gracilineustes acutus* (Lennier, 1887) Young *et al*., 2010
DATA FROM: Lennier (1887).
LOCALITY: Cap de la Hève, *Département du* Seine-Maritime, Haute-Normandie, France.
FORMATION: Marnes de Bléville Formation.
AGE: *Rasenia cymodoce* Sub-Boreal ammonite Zone, lower Kimmeridgian, Upper Jurassic.

(121) *Gracilineustes leedsi* (Andrews, 1913) Young *et al*., 2010
DATA FROM: CAMSM J64297, GLAHM V973, GLAHM V974, GLAHM V975, PETMG R24, PETMG R72, NHMUK PV R 2031, NHMUK PV R 2042, NHMUK PV R 3014, NHMUK PV R 3015, NHMUK PV R 3540 (holotype), NHMUK PV R 3899, NHMUK PV R 5793.
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(122) *Maledictosuchus nuyivijanan* Barrientos-Lara *et al*., 2018
DATA FROM: Barrientos-Lara *et al*. (2018).
LOCALITY: Llano Yosobé, near Tlaxiaco, Oaxaca, Mexico.
FORMATION: Sabinal Formation.
AGE: Kimmeridgian, Upper Jurassic.

(123) *Maledictosuchus riclaensis* Parrilla-Bel *et al*., 2013

DATA FROM: Parrilla-Bel *et al*. (2013).
LOCALITY: ‘‘Barranco de la Paridera’’, Ricla, Zaragoza, Spain.
FORMATION: Ágreda Formation.
AGE: *Erymnoceras coronatum* Sub-Mediterranean ammonite Zone, Middle Callovian, Middle Jurassic.

(124) Metriorhynchinae indeterminate (Cuba) [fragmentary taxon]
DATA FROM: USNM 419640.
LOCALITY: Viñales Valley, western Cuba.
FORMATION: Jagua Vieja Member, Jagua Vieja Formation.
AGE: middle or upper Oxfordian, Upper Jurassic.

(125) *Metriorhynchus geoffroyii* von Meyer, 1832 [fragmentary taxon]
DATA FROM: MHNG V-2232 (holotype).
LOCALITY: Le Havre, Département de Seine-Maritime, Haute-Normandie, France.
FORMATION: not given.
AGE: Kimmeridgian, Upper Jurassic.

(126) '*Metriorhynchus*' *palpebrosus* (Phillips, 1871)
DATA FROM: OUMNH J.29823 (holotype).
LOCALITY: Shotover Hill, Oxfordshire, UK.
FORMATION: Kimmeridge Clay Formation.
AGE: most likely lower Tithonian, Upper Jurassic.

(127) *Metriorhynchus superciliosus* (de Blainville, 1853)
DATA FROM: AMNH 997, GLAHM V942, GLAHM V963, GLAH V964, GLAHM V965, GLAHM V966, GLAHM V971, GLAHM V982, GLAHM V983, GLAHM V984, GLAHM V985, GLAHM V987, GLAHM V988, GLAHM V989, GLAHM V996, GLAHM V1004, GLAHM V1015, GLAHM V1027, GLAHM V1140, GLAHM V1142, GLAHM V1143, NHMUK PV R 1666, NHMUK PV R 2030, NHMUK PV R 2032, NHMUK PV R 2036, NHMUK PV R 2044, NHMUK PV R 2051, NHMUK PV R 2053, NHMUK PV R 2054, NHMUK PV R 2055, NHMUK PV R 2058, NHMUK PV R 2067, NHMUK PV R 3900, NHMUK PV R 6859, NHMUK PV R 6860, PETMG R10, PETMG R17, PETMG R18, PETMG R20, PETMG R42, PETMG R180, RMS M150, SMNS 10115, SMNS 10116, SMNS 81689; Andrews (1913).
LOCALITIES: outcrops from England and France.
FORMATIONS: Primarily: Oxford Clay Formation and Marnes de Dives Formation.
AGE: lower Callovian to lower Oxfordian, Middle-Upper Jurassic.

(128) *Rhacheosaurus gracilis* von Meyer, 1831
DATA FROM: AMNH 4804 and NHMUK PV R3961 (plastoholotypes), NHMUK PV R 3948.
LOCALITIES: Daiting (type locality) and Eichstätt, S Germany.

FORMATIONS: Mörnsheim Formation (type locality) and Solnhofen Formation.
AGE: *Hybonoticeras hybonotum* Tethys ammonite Zone, lower Tithonian, Upper Jurassic.

THALATTOSUCHIA: METRIORHYNCHIDAE: GEOSAURINAE (25 OTUs)

(129) cf. *Torvoneustes* [fragmentary taxon]
DATA FROM: MANCH J6459.
LOCALITY: Headington, Oxfordshire, UK.
FORMATION: most likely Beckley Sand Member, Kingston Formation.
AGE: middle Oxfordian, Upper Jurassic.

(130) *Dakosaurus andiniensis* Vignaud & Gasparini, 1996
DATA FROM: Gasparini *et al.* (2006), Pol & Gasparini (2009).
LOCALITIES: in the provinces of Neuquén and Mendoza, Argentina.
FORMATIONS: Vaca Muerta Formation, Mendoza Group and Neuquén Group. Neuquén Basin.
AGE: upper Tithonian, Upper Jurassic. Possibly also Berriasian, Lower Cretaceous.

(131) *Dakosaurus maximus* (Plieninger, 1846)
DATA FROM: NHMUK PV OR 33186, NHMUK PV OR 35766, NHMUK PV OR 35835-7, SMNS 8203 (neotype), SMNS 80148, SMNS 82043; Plieninger, 1846, Young & Andrade (2009), Andrade (2010), Andrade *et al.* (2010).
LOCALITIES: Numerous outcrops in England, Germany and France.
FORMATIONS: Numerous, including: Kimmeridge Clay Formation, Solnhofen Formation, Mergelstätten Formation and Nusplingen Plattenkalk.
AGE: upper Kimmeridgian-lower Tithonian, Upper Jurassic.

(132) Geosaurinae indeterminate (Argentina) [fragmentary taxon]
DATA FROM: Gasparini *et al*. (2005).
LOCALITY: Chacay Melehue, Neuquén Province, Argentina.
FORMATION: Los Molles Formation.
AGE: upper Bathonian, Middle Jurassic.

(133) *Geosaurus giganteus* (von Sömmerring, 1816)
DATA FROM: NHMUK PV R 1229 (holotype), NHMUK PV R 1230, NHMUK PV OR 37016, NHMUK PV OR 37020; Young & Andrade (2009), Andrade (2010), Andrade *et al.* (2010).
LOCALITIES: Daiting (type locality) and Eichstätt, Southern Germany.
FORMATIONS: Mörnsheim Formation (type locality) and Solnhofen Formation.
AGE: *Hybonoticeras hybonotum* Tethys ammonite Zone, lower Tithonian, Upper Jurassic.

(134) *Geosaurus grandis* (Wagner, 1858)

DATA FROM: BSPG AS-VI-1 (holotype); Young & Andrade (2009), Andrade (2010), Andrade *et al.* (2010).
LOCALITY: Daiting, near Monheim, Bayern, Germany.
FORMATIONS: Mörnsheim Formation.
AGE: *Hybonoticeras hybonotum* Tethys ammonite Zone, lower Tithonian, Upper Jurassic.

(135) *Geosaurus lapparenti* (Debelmas & Strannoloubsky, 1957)
DATA FROM: Debelmas (1952), Debelmas & Strannoloubsky (1957).
LOCALITY: La Martre, Département du Var, Provence-Alpes-Côte d'Azur, France.
FORMATION: not given.
AGE: *Neocomites peregrinus* ammonite Zone, upper Valanginian, Lower Cretaceous.

(136) *Ieldraan melkshamensis* Foffa *et al*., 2017
DATA FROM: NHMUK PV OR 46797.
LOCALITY: Melksham, Wiltshire, UK.
FORMATION: Oxford Clay Formation, Ancholme Group.
AGE: Callovian, Middle Jurassic.

(137) '*Metriorhynchus*' *brachyrhynchus* (Eudes-Deslongchamps, 1868c)
DATA FROM: GLAHM V978, GLAHM V995, NHMUK PV R 3541, NHMUK PV R 3699, NHMUK PV R 3700 (neotype), NHMUK PV R 3804, NHMUK PV R 4763, PETMG R19.
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(138) '*Metriorhynchus*' *casamiquelai* Gasparini & Chong, 1977
DATA FROM: Gasparini & Chong (1977).
LOCALITY: Quebrada Sajasa, Región de Antofagasta, Chile.
FORMATION: not given.
AGE: Callovian, Middle Jurassic.

(139) Swiss cf. '*Metriorhynchus*' *hastifer* [fragmentary taxon]
DATA FROM: NMO 26589.
LOCALITY: An abandoned quarry near Oberbuchsiten, Canton Solothurn, Switzerland.
FORMATION: Wettingen Member, Villigen Formation.
AGE: lower Kimmeridgian, Upper Jurassic.

(140) Chouquet cf. '*Metriorhynchus*' *hastifer*
DATA FROM: Lepage *et al*. (2008).
LOCALITY: Octeville-sur-Mer, *Département du* Seine-Maritime, Haute-Normandie, France.
FORMATION: Marnes de Bléville Formation.

AGE: *Rasenia cymodoce* Sub-Boreal ammonite Zone, lower Kimmeridgian, Upper Jurassic.

(141) '*Metriorhynchus*' *westermanni* Gasparini, 1980
DATA FROM: Gasparini *et al*. (2008), Fernández *et al*. (2011).
LOCALITY: Placilla de Caracoles (type locality), and Sierra del Medio, Región de Antofagasta, Chile
FORMATION: Mina Chica Formation (type locality) and Vergara Formation.
AGE: Callovian and Oxfordian, Middle and Upper Jurassic.

(142) Mr Leeds' dakosaur
DATA FROM: NHMUK PV R 3321, NHMUK PV R 4696, NHMUK PV R 4763.
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(143) Mr Passmore's Specimen
DATA FROM: OUMNH J1583.
LOCALITY: Swindon, Wiltshire, UK.
FORMATION: upper Kimmeridge Clay Formation.
AGE: lower Tithonian, Upper Jurassic.

(144) *Neptunidraco ammoniticus* Cau & Fanti, 2011
DATA FROM: Cau & Fanti (2011).
LOCALITY: unknown, but near Sant'Ambrogio di Valpolicella, Verona, Italy.
FORMATION: pseudonodular facies of lowermost Rosso Ammonitico Veronese Formation.
AGE: *Parkinsonia parkinsoni* ammonite Zone, uppermost Bajocian, Middle Jurassic.

(145) *Plesiosuchus manselii* (Hulke, 1870)
DATA FROM: NHMUK PV OR 40103 and NHMUK PV OR 40103a (holotype), NHMUK PV R 1089, MJML K181, MJML K434.
LOCALITIES: Westbury, Wiltshire; and Kimmeridge, Dorset (type locality), England, UK.
FORMATION: Kimmeridge Clay Formation, Ancholme Group.
AGE: *Aulacostephanus eudoxus* Sub-Boreal ammonite Zone, upper Kimmeridgian, to *Pectinatites wheatleyensis* Sub-Boreal ammonite Zone, lower Tithonian, Upper Jurassic.

(146) *Purranisaurus potens* Rusconi, 1948
DATA FROM: Herrera et al. (2015); high quality photographs of the holotype by Yanina Herrera.
LOCALITY: Arroyo del Arroyo del Cajón Grande, southwest Malargüe Department, Mendoza Province, Argentina.
FORMATION: Vaca Muerta Formation, Mendoza Group. Neuquén Basin.

AGE: *Substeueroceras koeneni* ammonite Zone, upper Tithonian or lower Berriasian, Upper Jurassic or Lower Cretaceous.

(147) *Suchodus durobrivensis* Lydekker, 1890
DATA FROM: NHMUK PV R 1994 (holotype), NHMUK PV R 2039
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(148) *Torvoneustes carpenteri* (Wilkinson *et al.*, 2008)
DATA FROM: BRSMG Ce 17365 (holotype), BRSMG Cd 7203; Wilkinson *et al.* (2008), Andrade (2010), Andrade *et al.* (2010).
LOCALITY: Westbury, Wiltshire, England, UK.
FORMATION: lower Kimmeridge Clay Formation, Ancholme Group.
AGE: *Aulacostephanus eudoxus* Sub-Boreal ammonite Zone, upper Kimmeridgian, Upper Jurassic.

(149) *Torvoneustes coryphaeus* Young *et al*., 2013b
DATA FROM: MJML K1863 (holotype).
LOCALITY: Swindon, Wiltshire, UK.
FORMATION: lower Kimmeridge Clay Formation, Ancholme Group.
AGE: *Pictonia baylei* Sub-Boreal ammonite Zone, lower Kimmeridgian, Upper Jurassic.

(150) *Torvoneustes mexicanus* (Wieland, 1910) [fragmentary taxon]
DATA FROM: Barrientos-Lara *et al*. (2016).
LOCALITY: imprecise, but likely near Tlaxiaco, Oaxaca, Mexico.
FORMATION: suggested to be Sabinal Formation.
AGE: suggested to be Kimmeridgian, Upper Jurassic.

(151) *Torvoneustes* sp. [fragmentary taxon]
DATA FROM: MJML K1707.
LOCALITY: Kimmeridge Bay, Dorset, UK.
FORMATION: Dorset succession, lower Kimmeridge Clay Formation, Ancholme Group.
AGE: *Aulacostephanus autissiodorensis* Sub-Boreal ammonite Zone, upper Kimmeridgian, Upper Jurassic.

(152) *Tyrannoneustes lythrodectikos* Young *et al*., 2013a
DATA FROM: GLAHM V972 (holotype), GLAHM V1145, NHMUK PV R 3939, PETMG R176.
LOCALITY: Peterborough, UK.
FORMATION: Peterborough Member, Oxford Clay Formation, Ancholme Group.
AGE: middle Callovian, Middle Jurassic.

(153) Vaches Noire dakosaur

DATA FROM: MNHN.F RJN 134a, ME 2012.4.68.
LOCALITY: Vaches Noires cliffs, Calvados, France
FORMATION: Marnes de Villers Formation (possibly also Marnes de Dives Formation).
AGE: ?Callovian and Oxfordian, Middle? and Upper Jurassic.

S2.2) H+Y dataset – character list

The character list (502 characters) for the Hastings + Young (H+Y) dataset used for one of the phylogenetic analyses herein. The characters are organised into the anatomical order listed in section S1. Comments on the characters and scoring are in italics, and precede the description of states. Osteological craniomandibular and dental characters constitute 72.112% (362/502) of the character list, osteological post-cranial characters contribute 26.892% (135/502), while soft-tissue characters contribute 0.996% (5/502).

Characters that are not applicable (i.e. cannot be scored) for all taxa are marked with an asterisk **(*)** following the character description. Characters treated as additive for the ordered-character analysis are denoted by **(ORDERED)** following the character description.

Abbreviations: ch., character; **ds**, dataset; **mod.**, modified; **rev.**, revised.

Skull geometry and dimensions (Ch. 1 – 10; 2.036% of characters)

#	Description
1	**Skull height, in posterior view:** *Clark (1994, ch. 3 mod.); Andrade & Bertini (2008a, ch. 2); Andrade et al. (2011, ch. 1); Ristevski et al. (2018, ds 1, ch. 1); Ősi et al. (2018, ds 1, ch. 1); Foffa et al. (2019, ch.1).* 0. skull higher than wide, or subequal 1. skull evidently wider than high
2	**Skull geometry, relative position of tooth row, quadrate articular facet and occipital condyle:** *Wu & Sues (1996, ch. 24 mod.); Sereno et al. (2003, ch. 46 mod.); Pol (2003, ch. 104 mod.); Turner & Buckley (2008, ch. 105 mod.); Andrade et al. (2011, ch. 2); Ristevski et al. (2018, ds 1, ch. 2); Ősi et al. (2018, ds 1, ch. 2); Foffa et al. (2019, ch.2).* *In its original format, this character assumed that the tooth row was always below the occipital condyle, which is not always true (e.g.* Pelagosaurus typus*). The original format was modified by Andrade et al. (2011) because in Mesoeucrocodylia each of its components (height of occipital condyle, quadrate condyle and tooth row) will relate to each other independently, therefore demanding more than the original three states to reflect their geometric relationships. Note also differences from the original scorings, and also the lack of agreement on the scorings by different authors, for the original format.* 0. tooth row and quadrate condyle aligned, both at a lower level than the occipital condyle 1. tooth row at a lower level than the quadrate condyle, which is aligned to the occipital condyle 2. tooth row, quadrate and occipital condyle all aligned in the same plane 3. tooth row and occipital condyle aligned, but quadrate condyle at a slightly lower level 4. tooth row and quadrate condyle unaligned and quadrate at a lower level, but both below the occipital condyle 5. tooth row and quadrate condyle unaligned and tooth row at a lower level, but both below the occipital condyle
3	**Skull geometry, relative position of tooth row and occipital condyle:** *Wu & Sues (1996, ch. 24 mod.); Sereno et al. (2003, ch. 46 mod.); Pol (2003, ch. 104 mod.); Turner & Buckley (2008, ch. 105 mod.); Andrade et al. (2011, ch. 3); Ristevski et al. (2018, ds 1, ch. 3); Ősi et al. (2018, ds 1, ch. 3); Foffa et al. (2019, ch.3).* 0. unaligned, tooth row at a lower level than occipital condyle 1. tooth row and occipital condyle aligned in the same plane
4	**Skull geometry, relative position of quadrate condyles and occipital condyle:** *Wu & Sues (1996, ch. 24 mod.); Sereno et al. (2003, ch. 46 mod.); Pol (2003, ch. 104 mod.); Turner & Buckley (2008, ch. 105 mod.); Andrade et al. (2011, ch. 4); Young et al. (2016, ds 2, ch.*

	148), Ristevski et al. (2018, ds 2, ch. 6); Smith et al. (in review, ds 1, ch. 7); Ősi et al. (2018, ds 1, ch. 4); Foffa et al. (2019, ch.4). *State (1) occurs in Neosuchia (with reversals in marine crocodyliforms, e.g. Dyrosauridae and cf.* Terminonaris robusta*).* 0. unaligned, quadrate condyles are at a lower level than the occipital condyle 1. quadrate condyles and occipital condyle aligned on the same plane
5	**Skull width to length ratio:** *Young et al. (2012, ch. 1); Young (2014, ch. 1); Young et al. (2016, ds 2, ch. 1); Ristevski et al. (2018, ds 2, ch. 1); Ősi et al. (2018, ds 1, ch. 5); Foffa et al. (2019, ch.5).* *= maximum width between the lateral-most points of the quadrates : basicranial length* 0. 0.26 or lower 1. between 0.27 and 0.4 2. 0.4 or greater
6	**Snout elongation:** *Jouve (2005, ch. 5 mod.); Hastings et al. (2010, ch. 1 mod.); Ristevski et al. (2018, ds 2, ch. 2); Ősi et al. (2018, ds 1, ch. 6); Foffa et al. (2019, ch.6).* *State (2) can only be scored for taxa where snout elongation is the result of the anteroposterior elongation of the maxilla (with the maxillae contact along their medial margins along the dorsal surface).* *State (1) occurs in most pholidosaurids, most dyrosaurids and gavialoids.* *State (2) occurs in Thalattosuchia and* Meridiosaurus*.* 0. both the nasals and maxillae not elongated 1. nasals and maxillae both elongated (having the sublongirostrine or longirostrine condition) 2. maxillae elongated, contacting each other along their medial margins. No elongation of the nasals (having the sublongirostrine or longirostrine condition)
7	**Rostrum, relation between height and width: (ORDERED)** *Clark (1994, ch. 3 mod.); Young (2006, ch. 8 mod.); Wilkinson et al. (2008, ch. 25 mod.); Young & Andrade (2009, ch. 25 mod.); Andrade et al. (2011, ch. 6 mod.); Young et al. (2011, ch. 25 mod.); Young et al. (2013a, ch. 1 mod.); Young et al. (2012, ch. 2 mod.); Young (2014, ch. 2 mod.); Young et al. (2016, ds 2, ch. 2 mod.), Ristevski et al. (2018, ds 2, ch. 3); Ősi et al. (2018, ds 1, ch. 7); Foffa et al. (2019, ch.7).* *State (0) does not imply the platyrostral condition, although that is the most likely morphology.* *State (1) does not imply the rostrum will be tubular, although a tubular rostrum is most likely (1) in proportion.* *State (2) does not imply the oreinirostral condition, although that is the most likely morphology.* 0. wider than high (lateromedial axis greater than dorsoventral axis, by more than 10%) 1. height and width subequal (lateromedial & dorsoventral axes subequal ±10%) 2. higher than wide (dorsoventral axis greater than lateromedial axis, by more than 10%)
8	**Rostrum, in dorsal view – amblygnathy ("bullet-shaped", with the rostrum retaining its width along almost all its length):** *Young et al. (2012, ch. 3); Young (2014, ch. 3); Young et al. (2016, ds 2, ch. 3), Ristevski et al. (2018, ds 2, ch. 4); Smith et al. (in review, ds 1, ch.4); Ősi et al. (2018, ds 1, ch. 8); Foffa et al. (2019, ch.8).* *State (1) is a putative apomorphy of* Dakosaurus + *Mr Leeds' dakosaur.* 0. no 1. yes
9	**Rostrum, presence of distinct flattening of the cranial rostrum dorsal surface and symphyseal dentary ventral surface:** *Smith et al. (in review, ds 1, ch. 5); Ősi et al. (2018, ds 1, ch. 9); Foffa et al. (2019, ch.9).* *State (1) occurs in* Sarcosuchus *and* Chalawan. *This character can be scored based on either the cranial or mandibular rostrum.* *This character scores the almost planar dentary symphyseal region, and the flattening of the cranial rostrum. Note, this character does not score for the 'duck'-billed morphology seen in some crocodylomorphs, only the flattening seen in the giant pholidosaurids.* 0. no 1. yes
10	**Rostrum narrows markedly in dorsal view, immediately in front of the orbits**

	Young et al. (2016, ds 2, ch. 4), Ristevski et al. (2018, ds 2, ch. 5); Smith et al. (in review, ds 1, ch. 6); Ősi et al. (20182, ds 1, ch. 10); Foffa et al. (2019, ch.10). *In Thalattosuchia, state (1) occurs in* Aeolodon priscus*,* Sericodon jugleri*,* Mycterosuchus nasutus*,* Bathysuchus megarhinus*,* Indosinosuchus potamosiamensis *and* Teleosaurus cadomensis. *Note that in many* Macrospondylus bollensis *specimens the dorsoventral compression of the skulls exaggerates the width of the temporal region.* 0. no 1. yes

Craniomandibular ornamentation (Ch. 11 – 19; 1.832% of characters)

#	Description
11	**Ornamentation (maxilla in dorsal view = external surface):** *Young & Andrade (2009, ch. 84 mod.); Young et al. (2011, ch. 84 mod.); Young et al. (2013a, ch. 2 mod.); Young et al. (2012, ch. 4 mod.); Young (2014, ch. 4); Young et al. (2016, ds 2, ch. 5), Ristevski et al. (2018, ds 2, ch. 7); Smith et al. (in review, ds 1, ch. 8); Ősi et al. (2018, ds 1, ch. 11); Foffa et al. (2019, ch.11).* 0. no conspicuous ornamentation, or ornamented with an irregular pattern of ridges, rugosities and anastomosing grooves 1. conspicuous circular-to-polygonally pitted pattern 2. conspicuous grooved-ridged pattern 3. conspicuous pits and grooves
12	**Ornamentation (prefrontal in dorsal view): (NEW)** *State (1) occurs in* Indosinosuchus potamosiamensis*,* Bathysuchus megarhinus*,* Sericodon jugleri*,* Plagiophthalmosuchus gracilirostris *and* Aeolodon priscus*.* 0. yes, with shallow to deep pits and/or grooves 1. no
13	**Ornamentation (lachrymal in dorsal view): (NEW)** *In Teleosauroidea state (1) occurs in* Indosinosuchus potamosiamensis*,* Sericodon jugleri*,* Aeolodon priscus*,* Plagiophthalmosuchus gracilirostris, *and* Macrospondylus bollensis*.* *In Metriorhynchoidea state (1) occurs in the subclade* Zoneait + *Metriorhynchidae.* 0. yes, with shallow to deep pits and/or grooves 1. no
14	**Ornamentation (frontal):** *Young (2006, ch. 1 mod.); Wilkinson et al. (2008, ch. 1 mod.); Young & Andrade (2009, ch. 1 mod.); Young et al. (2011, ch. 1 mod.); Young et al. (2013a, ch. 46 mod.); Young et al. (2012, ch. 55 mod.); Young (2014, ch. 57); Young et al. (2016, ds 2, ch. 65), Ristevski et al. (2018, ds 2, ch. 8); Smith et al. (in review, ds 1, ch. 9); Ősi et al. (2018, ds 1, ch. 12); Foffa et al. (2019, ch.12).* *In metriorhynchids, the main body of the frontal can be largely or entirely 'smooth', while the anteromedial process is ornamented. If this process is ornamented, the taxon was still scored from states (0–2).* 0. yes, with shallow to deep elliptical pits and shallow to deep grooves 1. yes, shallow to deep elliptical pits 2. yes, shallow to deep grooves 3. no
15	**Frontal, extension of ornamentation: (*) (NEW)** *In Teleosauroidea, state (0) occurs in the Chinese teleosauroid,* Teleosaurus cadomensis, Platysuchus multiscrobiculatus, Mystriosaurus laurillardi, Macrospondylus bollensis, Plagiophthalmosuchus gracilirostris*,* Clovesuurdameredeor stephani*,* Indosinosuchus *species, and* Mycterosuchus nasutus. *This character is not applicable for taxa that lack ornamentation on the frontal.* 0. extends from the centre of the frontal to lateral- and anterior-most regions 1. restricted to centre of the frontal
16	**Ornamentation (dorsal surface of the medial temporal region, typically the intertemporal bar):**

	Jouve et al. (2005b, ch. 30 mod.); Jouve et al. (2008, ch. 30 mod.); Hastings et al. (2010, ch. 8 mod.), Ristevski et al. (2018, ds 2, ch. 9 mod.); Smith et al. (in review, ds 1, ch. 10 mod.); Ősi et al. (2018, ds 1, ch. 13); Foffa et al. (2019, ch.13). *Note, herein we have re-worded this character to score for ornamentation along the dorsal surface of the medial temporal region, and not the intertemporal bar. This allows taxa that lack supratemporal fenestrae (such as* Iharkutosuchus*) to be scored for this character.* 0. ornamented 1. unornamented
17	**Ornamentation (parietal in dorsal view):** *Jouve et al. (2005b, ch. 27 mod.); Jouve et al. (2008, ch. 27 mod.); Hastings et al. (2010, ch. 45 mod.), Ristevski et al. (2018, ds 2, ch. 10); Smith et al. (in review, ds 1, ch. 11); Ősi et al. (2018, ds 1, ch. 14); Foffa et al. (2019, ch.14).* 0. no conspicuous ornamentation 1. slight ornamentation 2. strongly ornamented with deep and/or numerous pits
18	**Sculpturing, palatal surface of maxilla:** *Ortega et al. (2000, ch. 2); Andrade et al. (2011, ch. 20); Ristevski et al. (2018, ds 1, ch. 20); Smith et al. (in review, ds 2, ch. 20); Ősi et al. (2018, ds 1, ch. 15); Foffa et al. (2019, ch.15).* *State (1) was also registered for* Sichuanosuchus*,* Shantungosuchus *and* Fruitachampsa *by Ortega et al. (2000), but the absence (0) in* Hemiprotosuchus *cannot be confirmed, as the specimen is preserved with mandible in occlusion. Palatal sculpturing is also present in a few notosuchians.* 0. absent, palatal surface smooth 1. present, palatal surface ornamented with ridges
19	**Sculpturing, presence on the palatal surface of pterygoid:** *Clark (1994, ch. 40); Andrade et al. (2011, ch. 21); Ristevski et al. (2018, ds 1, ch. 21); Smith et al. (in review, ds 2, ch. 21); Ősi et al. (2018, ds 1, ch. 16); Foffa et al. (2019, ch.16).* *State (1) is present in Protosuchidae.* 0. absent, surface smooth 1. present

Internal neuroanatomy, sensory systems and cranial exocrine glands

(Ch. 20 – 22; 0.203% of characters)

[Scoring any OTU for these characters can come from: CT scan datasets or specimens with the cranium broken showing said cavity. All characters in this section refer to internal anatomy, principally internal cavities and structures. Thus are not included in the sections referring to bones visible externally]

#	Description
20	**Enlarged paired blood vessels extending into and from the pituitary gland, presence:** *In thalattosuchians (such as* Plagiophthalmosuchus gracilirostris, Pelagosaurus typus*) the internal carotid and orbital arteries are hypertrophied.* *State (1) is a putative apomorphy of Thalattosuchia.* 0. absent, the internal carotid and orbital arteries are not enlarged 1. present, these vessels are noticeably enlarged (= hypertrophied)
21	**Enlarged paired dural venous sinus system dorsal to the hindbrain, presence:** *In thalattosuchians (such as* Plagiophthalmosuchus gracilirostris, Pelagosaurus typus, Cricosaurus araucanensis*) the posterior branch of the transverse dural venous sinus (= posterior middle cerebral vein) is hypertrophied.* *State (1) is a putative apomorphy of Thalattosuchia.* 0. absent, dural venous system is not enlarged 1. present, these sinuses are noticeably enlarged (= hypertrophied)
22	**Internal enlarged cephalic exocrine glands, presence:**

	Andrade et al. (2011, ch. 485 mod.); Ristevski et al. (2018, ds 2, ch. 386 mod.); Smith et al. (in review, ds 1, ch. 392 mod.); Ősi et al. (2018, ds 1, ch. 453); Foffa et al. (2019, ch.17). *The evidence for internal large cephalic exocrine glands is well supported (e.g. Fernández & Gasparini, 2000, 2008; Gandola et al., 2006; Fernández & Herrera, 2009), and interpreted as structures for salt excretion. In fossil specimens, lobulations for glands must show a regular pattern, and have no trabecular bones, which otherwise indicate the presence of pneumatic cells of air sinuses (Fernández & Herrera, 2009).* *Note that in metriorhynchids the chambers housing these enlarged glands indicate their presence.* *These enlarged nasal glands are also associated with gland drainage ducts.* *State (1) occurs in Metriorhynchidae.* 0. absent, nasal glands not enlarged 1. present, nasal glands enlarged (= hypertrophied), being bound externally by the nasal, prefrontal, lachrymal, maxilla and jugal

Craniomandibular pneumaticity (Ch. 23 – 26; 0.814% of characters)
[Scoring any OTU for these characters can come from: CT scan datasets or specimens with the cranium broken showing said cavity. All characters in this section refer to internal pneumatic cavities or the enclosure of pneumatic structures by bone. Thus are not included in the sections referring to bones visible externally]

#	Description
23	**Supraoccipital, internal presence of the cavity for the intertympantic diverticulum of the pharyngotympanic sinus system (= the "mastoid antrum"):** *Clark (1994, ch. 63 mod.); Andrade et al. (2011, ch. 282 mod.); Ristevski et al. (2018, ds 2, ch. 165); Smith et al. (in review, ds 1, ch. 169); Ősi et al. (2018, ds 1, ch. 186); Foffa et al. (2019, ch.18).* *As discussed by Wilberg (2015b), this character has been scored to unite Pholidosauridae and Dyrosauridae with Thalattosuchia. The natural external and internal mould* Pholidosaurus schaumburgensis *Bückeburg specimens held in Berlin show the cavity for this diverticulum (also see Wilberg, 2015b Figure 7c).* *Scoring any OTU as state (1) can come from CT scan datasets, or fossil specimens with a broken supraoccipital that show the cavity. However, scoring an OTU can only reliably come from CT scan datasets, or acid prepared specimens that have the braincase preserved. While this limits the number of OTUs that can be scored, it helps prevent potential mis-scorings.* *Here* Dyrosaurus*,* Sarcosuchus *and* Terminonaris *are scored as (?) until CT scans conclusively show the lack of this diverticulum.* *State (0) occurs in Thalattosuchia.* 0. absent (in Thalattosuchia this diverticulum is absent) 1. present
24	**Quadrate, openings on the dorsal surface at the proximal end (= subtympanic foramina; = quadrate fenestrae):** *Young & Andrade (2009, ch. 158 mod.); Young et al. (2011, ch. 158 mod.); Young et al. (2013a, ch. 104 mod.); Young et al. (2012, ch. 121 mod.); Young (2014, ch. 124 mod.); Young et al. (2016, ds 2, ch. 145 mod.); Ristevski et al. (2018, ds 2, ch. 198); Smith et al. (in review, ds 1, ch. 202); Ősi et al. (2018, ds 1, ch. 220); Foffa et al. (2019, ch.19).* *This character scores the presence of foramina on the proximal quadrate for the infundibular diverticula of the pharyngotympanic sinus system contacting the tympanum.* *State (2) occurs in Thalattosuchia.* 0. multiple subtympanic foramina 1. single subtympanic foramen 2. lacks subtympanic foramina
25	**Quadrate (and articular), foramina aërum presence:**

	Ristevski et al. (2018, ds 2, ch. 199); Smith et al. (in review, ds 1, ch. 203); Ősi et al. (2018, ds 1, ch. 221); Foffa et al. (2019, ch.20). *This character scores the presences of the aërum foramina on the dorsal or mediodorsal surface of the distal quadrate, and the associated opening on the dorsal or medial surface of the retroarticular process of the mandible. These foramina are for the siphonium connecting the quadrate and articular diverticula of the pharyngotympanic sinus system.* *Note that in large adults the articular diverticula can completely regress, thus the quadrate aërum foramen may be the best indicator of the structure's presence.* *Following Nesbitt (2011; discussion on ch. 159), basal crocodylomorphs (i.e. 'sphenosuchians') the large medial articular foramina are not considered to be articular aërum foramina. Whether basal crocodylomorphs had articular diverticula is currently unknown.* *State (0) occurs in Thalattosuchia (basal crocodylomorphs are scored as '?').* *State (1) is currently only known to occur in Crocodyliformes.* 0. absent 1. present
26	**Median pharyngeal and pharyngotympanic tubes (= "Eustachian tubes"), relation to basioccipital and basisphenoid: (ORDERED)** *Clark (1994, ch. 52 mod.); Andrade et al. (2011, ch. 290 mod.); Nesbitt (2011, ch. 121 – based on Gower 2002, ch. 13); Young et al. (2013a, ch. 108); Young et al. (2012, ch. 126); Young (2014, ch. 130); Young et al. (2016, ds 2, ch. 152); Ristevski et al. (2018, ds 2, ch. 206); Smith et al. (in review, ds 1, ch. 210); Ősi et al. (2018, ds 1, ch. 228); Foffa et al. (2019, ch.21).* *State (1) occurs in* Postosuchus *and 'sphenosuchians'.* *State (2) occurs in Crocodyliformes.* 0. not enclosed by bone 1. partially enclosed between the basioccipital and basisphenoid 2. entirely enclosed between the basioccipital and basisphenoid

Rostral neurovascular foramina (Ch. 27 – 32; 1.221% of characters)

#	Description
27	**Neurovascular foramina, presence of an expanded network of openings on the dorsal surface of the rostrum and ventral-lateral surfaces of the mandible:** *Andrade et al. (2011, ch. 22), Ristevski et al. (2018, ds 2, ch. 11); Smith et al. (in review, ds 1, ch. 12); Ősi et al. (2018, ds 1, ch. 17); Foffa et al. (2019, ch.22).* *Based on the data by Soares (2002), where neurovascular foramina are related to the presence of dome pressure receptors (DPR).* *Three groups of teleosauroids score as state (1) – Machimosaurini and* Mystriosaurus laurillardi*.* *Some other species of teleosauroids have the anterior tip of the dentary covered in numerous foramina, even though they have only the basal single line of foramina on the maxillae. In all thalattosuchians the dentary foramina are greater in number, and are easier to observe. In teleosauroids with no/little premaxillary/maxillary ornamentation, the accessory foramina are visible on the premaxilla and on the anterior maxillae. In Machimosaurini these foramina are much more numerous, and therefore easier to identify.* *Metriorhynchids however clearly have accessory foramina on the premaxillae, maxillae and dentaries, although they do not have the 'beehive-like' arrangement mentioned for extant taxa.* *The maxillary foramina can be observed across the element, and are not restricted to the anterior maxilla as in teleosauroids.* Pelagosaurus typus *has clear accessory foramina on the anterior dentaries, and perhaps has some on the premaxilla so it is here scored as (0).* *It is unclear whether the thalattosuchian condition is homologous to that seen in neosuchians (or whether it evolved multiple times within Thalattosuchia).* *This character might need to be re-evaluated, as George & Holliday (2013) have questioned the utility of using facial neurovascular foramina as osteological correlates for the DPR system.* 0. absent, neurovascular openings limited to a single line, near the ventral margin of the rostrum and dorsal margin of dentary 1. present at least at the premaxillae, maxillae and dentaries
28	**Neurovascular foramina (premaxilla), overall distance to the alveolar margin and teeth:**

	Andrade & Bertini (2008, ch. 17 part); Andrade et al. (2011, ch. 23); Ristevski et al. (2018, ds 1, ch. 23); Smith et al. (in review, ds 2, ch. 23); Ősi et al. (2018, ds 1, ch. 18). *Note that Andrade et al. (2011) substantially re-scored this character from the original (Andrade & Bertini 2008, ch17), and that complementary characters on neurovascular foramina are present.* 0. ventral-most foramina reach area next to the alveolar margin, close to teeth 1. ventral-most foramina clearly apart from the alveolar margin, distant to the teeth
29	**Neurovascular foramina (anterior maxilla), overall distance to the alveolar margin and teeth:** *Andrade & Bertini (2008, ch. 17 part); Andrade et al. (2011, ch. 24); Ristevski et al. (2018, ds 1, ch. 24); Smith et al. (in review, ds 2, ch. 24); Ősi et al. (2018, ds 1, ch. 19); Foffa et al. (2019, ch.24).* *State (0) is putative apomorphy of derived eusuchians, but is also present in other mesoeucrocodylian clades.* *State (1) is a common condition in Crocodylomorpha, occurring even in basal eusuchians.* 0. ventral-most foramina reach area next to the alveolar margin, close to teeth 1. ventral-most foramina clearly apart from the alveolar margin, distant to the teeth
30	**Neurovascular foramina (mid maxilla) forming a strongly arched line at mid-rostrum, at maturity:** *Andrade et al. (2011, ch. 25); Ristevski et al. (2018, ds 1, ch. 25); Smith et al. (in review, ds 2, ch. 25); Ősi et al. (2018, ds 1, ch. 20); Foffa et al. (2019, ch.25).* *State (1) is putative apomorphy of* Araripesuchus. 0. absent, line of foramina follows the overall outline of the margin 1. present, ample area of smooth margin ventral to the arched line of foramina
31	**Neurovascular foramina (posterior maxilla), distribution on the alveolar margin:** *Andrade et al. (2011, ch. 26); Young et al. (2016, ds 2, ch. 26), Ristevski et al. (2018, ds 2, ch. 12); Smith et al. (in review, ds 1, ch. 13); Ősi et al. (2018, ds 1, ch. 21); Foffa et al. (2019, ch.26).* *State (1) occurs in goniopholidids.* 0. ventral-most foramina not high on the maxillary margin, either close or next to the alveoli 1. ventral-most foramina high on the maxilla (up to twice the distance from other foramina), very distant to the alveoli
32	**Neurovascular foramina (dentary), distribution of neurovascular foramina relative to the alveolar margin, in non-tubular snouted forms: (*)** *Andrade et al. (2011, ch. 27); Ristevski et al. (2018, ds 1, ch. 27); Smith et al. (in review, ds 2, ch. 27); Ősi et al. (2018, ds 1, ch. 22); Foffa et al. (2019, ch.27).* *This character is not applicable for taxa that have tubular snouts.* *State (1) occurs in Crocodylia.* 0. foramina form a simple straight to ventrally-arched line 1. foramina form a sinusoid line, following the dorsal flutings, when flutings are present

Cranial rostrum (Ch. 33 – 94; 12.627% of characters)

[external nares, dermatocranial bones (= os præmaxillare, ossa nasalia, os maxillare and ossa lacrimalia), antorbital cavity]

#	Description
33	**Perinarial crests, presence and morphology:** *Andrade et al. (2011, ch. 29); Ristevski et al. (2018, ds 1, ch. 29); Smith et al. (in review, ds 2, ch. 29); Ősi et al. (2018, ds 1, ch. 23); Foffa et al. (2019, ch.28).* *State (1) is present within Goniopholididae (*Anteophthalmosuchus, Hulkeopholis, Goniopholis *and* Amphicotylus*).* 0. absent, surface even or bearing a perinarial fossa 1. present as well defined and distinct ridges, cornering the lateral to posterior borders of the naris
34	**External nares orientation:**

	Turner & Pritchard (2015, ch. 6; modified from Clark 1994, ch. 6); Young et al. (2016, ds 2, ch. 8), Ristevski et al. (2018, ds 2, ch. 14); Smith et al. (in review, ds 1, ch. 15); Ősi et al. (2018, ds 1, ch. 24); Foffa et al. (2019, ch.29). *In Thalattosuchia, state (0) occurs in the teleosauroids* Mycterosuchus nasutus, *the Chinese teleosauroid,* Platysuchus multiscrobiculatus*,* Teleosaurus cadomensis*,* Indosinosuchus *species,* Aeolodon priscus*,* Sericodon jugleri*,* Mystriosaurus laurillardi *and* Bathysuchus megarhinus. *Note that in* Mystriosaurus laurillardi*, the external nares are oriented anteriorly, while in aforementioned taxa it is oriented anterodorsally.* 0. orientated anteriorly, anterodorsally, or anterolaterally 1. orientated mainly dorsally, or dorsolaterally
35	**External nares, shape in dorsal view:** *Young (2006, ch. 6 mod.); Wilkinson et al. (2008, ch. 23 mod.); Young & Andrade (2009, ch. 23 mod.); Young et al. (2011, ch. 23 mod.); Young et al. (2013a, ch. 4 mod.); Young et al. (2012, ch. 6 mod.); Young (2014, ch. 6 mod.); Young et al. (2016, ds 2, ch. 9), Ristevski et al. (2018, ds 2, ch. 15); Smith et al. (in review, ds 1, ch. 16); Ősi et al. (2018, ds 1, ch. 25); Foffa et al. (2019, ch.30).* *State (4) is a putative apomorphy of Susisuchidae.* 0. subcircular (diameter in any direction does not vary by more than ± 10%) 1. oval (dorsal width is greater than 10% longer than anteroposterior length) 2. 'D-shaped', with posterior edge straight 3. spoon-shaped elongate ellipse (dorsal width is less than 40% of anteroposterior length) 4. pear-shaped 5. external nares not exposed in dorsal view
36	**External nares, shape in anterior view:** *Figured in Foffa et al. (2019).* *State (1) occurs in* Aeolodon priscus*,* Indosinosuchus potamosiamensis*,* Bathysuchus megarhinus*,* Mystriosaurus laurillardi*, and the Chinese teleosauroid.* 0. subcircular or 'B-shaped' (the anterior margin is relatively straight) 1. noticeably '8-shaped'
37	**Medial tubercles of external nares on the posterior margin:** *Hastings et al. (2010, ch. 2 mod.), Ristevski et al. (2018, ds 2, ch. 16); Smith et al. (in review, ds 1, ch. 17); Ősi et al. (2018, ds 1, ch. 26); Foffa et al. (2019, ch.31).* *States (1+2) are putative apomorphies of Dyrosauridae.* 0. absent 1. dorsal 2. ventral
38	**Thickness of the anterior margin of the external nares: (*)** *Hastings et al. (2010, ch. 3 mod.), Ristevski et al. (2018, ds 2, ch. 17); Smith et al. (in review, ds 1, ch. 18); Ősi et al. (2018, ds 1, ch. 27); Foffa et al. (2019, ch.32).* *State (1) occurs in basal dyrosaurids.* *This character is not applicable for taxa that have posterodorsally retracted external nares (i.e. rhacheosaurin metriorhynchids).* 0. less than half anteroposterior length 1. greater than half anteroposterior length, or in species with a broad snout the anterior premaxilla is noticeably thick with the external nares posterior to the P1 alveoli
39	**External nares, posterodorsal retraction in relation to the tooth-row: (ORDERED)** *Young (2006, ch. 16 mod.); Wilkinson et al. (2008, ch. 38 mod.); Young & Andrade (2009, ch. 38 mod.); Young et al. (2011, ch. 38 mod.); Young et al. (2013a, ch. 5 mod.); Young et al. (2012, ch. 7 mod.); Young (2014, ch. 7 mod.); Young et al. (2016, ds 2, ch. 10), Ristevski et al. (2018, ds 2, ch. 18); Smith et al. (in review, ds1, ch. 19); Ősi et al. (2018, ds 1, ch. 28); Foffa et al. (2019, ch.33).* *This character was designed to quantify the degree of posterodorsal retraction of the external nares in Metriorhynchidae. Its level relative to the tooth-row is used in this regard.* *Previous states (4–6) of this character were removed by Young et al. (2016) as the maxillary tooth count is too variable.* 0. at the tip of the snout, with its posterior-margin not exceeding the first premaxillary alveolus 1. at the tip of the snout, but its posterior-margin does exceed the last premaxillary alveolus

	2. the posterior-margin reaches to the beginning of the 1st maxillary alveolus 3. posterodorsally displaced, anterior-margin begins posterior to the 1st premaxillary alveolus while the posterior-margin exceeds the beginning of the 1st maxillary alveolus
40	**Perinarial crests, presence and morphology:** *Andrade et al. (2011, ch. 29), Ristevski et al. (2018, ds 2, ch. 19); Smith et al. (in review, ds 1, ch. 20); Ősi et al. (2018, ds 1, ch. 29); Foffa et al. (2019, ch.34).* *State (1) is present within Goniopholididae (*Anteophthalmosuchus, Goniopholis *and* Amphicotylus*).* 0. absent, surface even or bearing a perinarial fossa 1. present as well defined and distinct ridges, cornering the lateral to posterior borders of the naris
41	**Intranarial fossa, presence at the lateral walls, inside narial cavity, at the vestibulum:** *Andrade et al. (2011, ch. 42), Ristevski et al. (2018, ds 2, ch. 20); Smith et al. (in review, ds 1, ch. 21); Ősi et al. (2018, ds 1, ch. 30); Foffa et al. (2019, ch.35).* *State (1) is putative apomorphy of Thalattosuchia.* *The internarial fossa is an additional chamber that creates an internal border of the external naris; must not be mistaken with the naso-oral fossa, or with the perinarial fossa.* *Note, unlike Andrade et al. (2011), we consider this to present in all thalattosuchians. A distinct fossa within the nasal cavity is seen in all teleosauroids and* Pelagosaurus typus*, however due to dorsoventral crushing the fossa can be obscured.* 0. absent 1. present
42	**Premaxilla, dorsal/anterodorsal projection of the anterodorsal margin (anterior to the external nares):** *Young et al. (2016, ds 2, ch. 11), Ristevski et al. (2018, ds 2, ch. 21); Smith et al. (in review, ds 1, ch. 22); Ősi et al. (2018, ds 1, ch. 31); Foffa et al. (2019, ch.36).* *State (1) occurs in derived pholidosaurids*, *as well as in eusuchians.* 0. present 1. absent
43	**Premaxilla, in dorsal view, anteroposterior length relative to rostrum length, from anterior-most premaxillae to anterior orbital margin: (*) (NEW)** *In Teleosauroidea state (1) is the basal condition, with state (0) occurring in* Machimosaurus buffetauti*,* Machimosaurus mosae*,* Mystriosaurus laurillardi *and the Chinese teleosauroid.* *In Metriorhynchoidea, state (0) is the basal condition (seen in* Pelagosaurus typus *and* Teleidosaurus calvadosii*), with state (1) defining Metriorhynchidae.* *This character is not applicable for taxa where the nasals contact the premaxilla.* 0. less than 25% of rostrum length 1. approximately 25% (or more) of rostrum length
44	**Premaxilla, lateral expansion anterior to the premaxilla-maxilla suture due to the enlargement of the P3 alveoli, with a constriction immediately posterior to the expansion:** *Hastings et al. (2010, ch. 14 mod.), Ristevski et al. (2018, ds 2, ch. 22); Smith et al. (in review, ds 1, ch. 23); Ősi et al. (2018, ds 1, ch. 33); Foffa et al. (2019, ch.38).* *State (1) occurs in basal dyrosaurids.* *Note that unlike other lateral expansions of the premaxilla, this does not correlate with a lateral expansion of the dentary.* 0. absent 1. present
45	**Premaxilla, length compared to width: (*)** *Jouve et al. (2008, ch. 41 mod.); Hastings et al. (2010, ch. 22 mod.), Ristevski et al. (2018, ds 2, ch. 23); Smith et al. (in review, ds 1, ch. 24); Ősi et al. (2018, ds 1, ch. 34); Foffa et al. (2019, ch.39).* *State (1) occurs in derived dyrosaurids.* *This character is not applicable for taxa that have posterodorsally retracted external nares.* 0. slightly longer than wide 1. nearly three times longer than wide, or more than three times longer than wide
46	**Premaxilla, ventral surface, presence of large depressions/notches for reception of the D1 teeth:**

	Ristevski et al. (2018, ds 2, ch. 24); Smith et al. (in review, ds 1, ch. 25); Ősi et al. (2018, ds 1, ch. 35). *State (1) occurs in the pholidosaurids* Terminonaris, Meridiosaurus, Sarcosuchus *and* Oceanosuchus, *goniopholidids* Anteophthalmosuchus sp., Amphicotylus stovalli *and* Calsoyasuchus, *and basal dyrosaurids* (e.g. Cerrejonisuchus). *State (2) occurs in* Elosuchus cherifiensis *and* E. broinae. 0. absent 1. occurs posterior to either the P1–P2 (or just the P2) alveoli, and are ventral to the external nares 2. occurs between, and separates, the P1–P2 alveoli from the P3–P4 alveoli
47	**Premaxilla, when seen in lateral view: (ORDERED)** *Young et al. (2016, ds 2, ch. 13 mod.), Ristevski et al. (2018, ds 2, ch. 26); Smith et al. (in review, ds 1, ch. 27); Ősi et al. (2018, ds 1, ch. 36); Foffa et al. (2019, ch.41).* *This character scores the 'pholidosaurid beak'. However,* Meridiosaurus *does not have a fully sub-vertical 'beak', but do have an intermediate morphology. This morphology is herein considered homologous to the ventral alveolar row of goniopholidids and basal dyrosaurids. This character is not applicable for Teleosauroidea.* *State (1) occurs in* Meridiosaurus, Elosuchus, *and the French* Pholidosaurus, *and in the goniopholidids* Anteophthalmosuchus sp., Amphicotylus stovalli *and* Goniopholis kiplingi, *and the basal dyrosaurid* Cerrejonisuchus. *State (2) occurs in the pholidosaurids* Chalawan, Sarcosuchus, Terminonaris *and* Oceanosuchus. 0. the anterior and anterolateral margins are not sub-vertical, and do not extend ventrally when compared to the rest of the premaxilla (i.e. the dentigerous margins) 1. the anterior and anterolateral margins are slightly sub-vertical, and slightly extend ventrally to the rest of the element 2. the anterior and anterolateral margins are fully sub-vertical and extend ventrally to the rest of the element
48	**Premaxilla, when seen in lateral view:** *Ristevski et al. (2018, ds 2, ch. 27); Smith et al. (in review, ds 1, ch. 28); Ősi et al. (2018, ds 1, ch. 37); Foffa et al. (2019, ch.42).* *This character is not applicable for pholidosaurids and goniopholids.* *State (1) occurs in the teleosauroids* Mycterosuchus nasutus, *the Chinese teleosauroid,* Platysuchus multiscrobiculatus*,* Mystriosaurus laurillardi*,* Indosinosuchus *species,* Bathysuchus megarhinus*,* Sericodon jugleri *and* Aeolodon priscus. *This character is not homologous to the pholidosaurid ventral verticalisation of the premaxilla, as in this sub-set of teleosauroids the premaxilla is strongly orientated anteroventrally in lateral view.* 0. the anterior and anterolateral margins are either not sub-vertical, or do not extend ventrally when compared to the rest of the premaxilla (i.e. the dentigerous margins) 1. the anterior and anterolateral margins are orientated anteroventrally and extend ventrally to the rest of the element.
49	**Premaxilla, proportion of total length posterior to the external nares:** *Wilkinson et al. (2008, ch. 21); Young & Andrade (2009, ch. 21); Young et al. (2011, ch. 21); Young et al. (2013a, ch. 6); Young et al. (2012, ch. 8); Young (2014, ch. 8); Young et al. (2016, ds 2, ch. 14) Ristevski et al. (2018, ds 2, ch. 28); Smith et al. (in review, ds 1, ch. 29); Ősi et al. (2018, ds 1, ch. 38); Foffa et al. (2019, ch.43).* 0. greater than 67% of premaxilla total length is posterior to the external nares 1. between 50–65% 2. between 36–45% 3. 28% or less
50	**Premaxilla, posterodorsal (= maxillary, = subnarial) process, termination:** *Nesbitt & Desojo (2017, ch. 415); Ősi et al. (2018, ds 1, ch. 39); Foffa et al. (2019, ch.44).* *State (1) occurs in Crocodylomorpha.* 0. anterior to or at the posterior end of the external naris 1. posterior of the posterior extension of the external naris
51	**Premaxilla, posterodorsal process: (*)**

	Young (2014, ch. 9); Young et al. (2016, ds 2, ch. 15); Ristevski et al. (2018, ds 2, ch. 29); Smith et al. (in review, ds 1, ch. 30); Ősi et al. (2018, ds 1, ch. 40); Foffa et al. (2019, ch.45). *State (1) occurs in* Tyrannoneustes lythrodectikos, Torvoneustes, 'Metriorhynchus' hastifer *and Mr Passmore's specimen.* *This character is not applicable for taxa that retract their external nares (i.e. rhacheosaurin metriorhynchids).* 0. short, terminates level to the fourth maxillary alveolus, or more anteriorly 1. long, terminates level to the end of the fourth maxillary alveolus, or more posteriorly
52	**Premaxilla, development of premaxillary septum:** *Young (2006, ch. 7 mod.); Wilkinson et al. (2008, ch. 24 mod.); Young & Andrade (2009, ch. 24 mod.); Young et al. (2011, ch. 24 mod.); Young et al. (2013a, ch. 7); Young et al. (2012, ch. 9); Young (2014, ch. 10); Young et al. (2016, ds 2, ch. 16); Ristevski et al. (2018, ds 2, ch. 30); Smith et al. (in review, ds 1, ch. 31); Ősi et al. (2018, ds 1, ch. 41); Foffa et al. (2019, ch.46).* *State (1) scores the premaxillary septum of Metriorhynchidae.* *Terminonaris currently scored as '?', as it is unclear whether there was also a separating septum present.* *Young et al. (2013a) changed this character from a multi-state to its present binary form. Currently, only Rhacheosaurini metriorhynchids are definitively known to have had a full premaxillary septum, however specimens of* Metriorhynchus superciliosus*, 'M.' brachyrhynchus, Mr Passmore's specimen and* Tyrannoneustes lythrodectikos *have preserved: the proximal end of the bar, and the raised distal articulation region on the premaxilla associated with the anterior end of the bar in Rhacheosaurini. Thus, they have been scored as (1). It is possible that only Rhacheosaurini has a fully ossified premaxillarybar, or the incomplete bar could be due to post-mortem damage.* *It is not homologous with other crocodylomorph septa, which are either partially formed by the nasals, or do not originate on the external surface of the premaxilla immediately anterior to the nasal fossa.* 0. no septum, with a single undivided external naris, or a divided external naris not formed solely by a premaxillary septum 1. external nares dorsally divided by a midline premaxillary septum
53	**Rostrum, morphology of the external surface of premaxilla and maxilla:** *based on Pol (1999, ch. 153); Andrade et al. (2011, ch. 55); Ristevski et al. (2018, ds 2, ch. 31); Smith et al. (in review, ds 1, ch. 32); Ősi et al. (2018, ds 1, ch. 42); Foffa et al. (2019, ch.47).* *State (1) is putative apomorphy of Notosuchidae + Sphagesauridae.* *Most commonly in state (1), the ventral plane will face laterally and slightly ventrally; the dorsal plane will face laterodorsally.* 0. rostrum with a continuous surface, either convex or plain 1. rostrum with distinct ventral and dorsal surfaces, plain and separated by a somewhat distinct anteroposterior ridge or edge
54	**Rostrum, type of constriction at the premaxilla-maxilla suture:** *Clark (1994, ch. 9 mod.); Wilkinson et al. (2008, ch. 20 mod.); Young & Andrade (2009, ch. 20 mod.); Andrade et al. (2011, ch. 57); Young et al. (2011, ch. 20 mod.); Young et al. (2013a, ch. 75 mod.); Young et al. (2012, ch. 88 mod.); Young (2014, ch. 90 mod.); Young et al. (2016, ds 2, ch. 108 mod.); Ristevski et al. (2018, ds 2, ch. 32); Smith et al. (in review, ds 1, ch. 33); Ősi et al. (2018, ds 1, ch. 43); Foffa et al. (2019, ch.48).* *State (0) is a putative apomorphy of* Araripesuchus*.* *The vast majority of crocodylomorphs can be considered as (1), but highly predaceous forms will show a well-defined notch at the premaxilla-maxilla suture (2).* 0. narrow slit 1. wide, poorly-defined concavity, or not constricted at all 2. well-defined notch

55	**Premaxillae anterior to naris, morphology:** *Clark (1995, ch. 5 mod.); Andrade et al. (2011, ch. 62); Ristevski et al. (2018, ds 2, ch. 33); Smith et al. (in review, ds 1, ch. 34); Ősi et al. (2018, ds 1, ch. 44); Foffa et al. (2019, ch.49).* *State (0) is putative apomorphy of Notosuchidae + Sphagesauridae.* *State (1) is a putative apomorphy of* Araripesuchus + Libycosuchus*.* 0. anterior rami of premaxillae do not meet medially, anterior/ventral to naris, with both premaxillae in contact only through palatine rami 1. anterior rami of premaxillae meet anterior to naris, through a very narrow band, but not projecting vertically 2. anterior rami of premaxillae broadly meet anterior to naris, forming a vertical wall, which may be straight or slightly convex
56	**Premaxilla, in dorsal view, anterior and posterior medial margin of external nares formed by two bulbous projections, creating a distinct '8'-shape: (NEW)** *State (1) occurs in* Bathysuchus megarhinus *and* Mycterosuchus nasutus. 0. absent 1. present
57	**Premaxilla, type of contact with maxilla:** *Clark (1994, ch. 8); Andrade et al. (2011, ch. 63); Ristevski et al. (2018, ds 2, ch. 34); Smith et al. (in review, ds 1, ch. 35); Ősi et al. (2018, ds 1, ch. 45); Foffa et al. (2019, ch.50).* *State (1) is a putative apomorphy of Crocodyliformes.* 0. premaxilla loosely overlies maxilla on face 1. premaxilla and maxilla suture together along butt joint
58	**Premaxilla, in dorsal view, shape of anteroposterior premaxilla-maxilla contact: (NEW)** *State (0) occurs in* Aeolodon priscus*, Chinese teleosauroid,* Indosinosuchus *species*, Platysuchus multiscrobiculatus*,* Mycterosuchus nasutus*,* Macrospondylus bollensis*,* Plagiophthalmosuchus gracilirostris*,* Bathysuchus megarhinus*, Sericodon jugleri*, *Aeolodon priscus* and *Macrospondylus bollensis*. *State (2) occurs in* Charitomenosuchus leedsi. 0. triangular (V-shaped) – little or no interdigitating margin 1. subcircular - moderately interdigitating margin 2. strongly interdigitating 'ragged' margin
59	**Distance between premaxilla and nasal:** *Young (2006, ch. 5 mod.); Wilkinson et al. (2008, ch. 22 mod.); Young & Andrade (2009, ch. 22 mod.); Young et al. (2011, ch. 22 mod.); Young et al. (2013a, ch. 8 mod.); Young et al. (2012, ch. 10); Young (2014, ch. 11); Young et al. (2016, ds 2, ch. 17); Ristevski et al. (2018, ds 2, ch. 35); Smith et al. (in review, ds 1, ch. 36); Ősi et al. (2018, ds 1, ch. 46); Foffa et al. (2019, ch.51).* *State (2) occurs in* Meridiosaurus *and* Gavialis gangeticus. *States (1+2) are putative apomorphies of Thalattosuchia. However, with reversals, some specimens of* 'Metriorhynchus' brachyrhynchus *have contact between these elements, and the posterodorsal retraction of the external nares in* 'Cricosaurus' macrospondylus *results in contact between these elements.* 0. none, premaxilla and nasal contact 1. small, less than half the midline length of the premaxilla 2. large, approximately 80% to more than 100% of the midline length of the premaxilla
60	**Nasal contribution to the margin of the external nares:** *Young et al. (2012, ch. 11); Young (2014, ch. 12); Young et al. (2016, ds 2, ch. 18); Ristevski et al. (2018, ds 2, ch. 36); Smith et al. (in review, ds 1, ch. 37); Ősi et al. (2018, ds 1, ch. 47); Foffa et al. (2019, ch.52).* 0. present 1. absent
61	**Anterior process of the nasals, anterior margin relative to the first maxillary alveoli: (*)** *Jouve et al. (2008, ch. 42 mod.); Hastings et al. (2010, ch. 33 mod.); Ristevski et al. (2018, ds 2, ch. 37); Smith et al. (in review, ds 1, ch. 38); Ősi et al. (2018, ds 1, ch. 48); Foffa et al. (2019, ch.53).* *State (0) occurs in pholidosaurids and derived dyrosaurids.* *Note that this character scores the posterior-ward position of the anterior margin of the nasal anterior process, due to the elongation of the premaxillary posterior process only.*

	This character is not applicable for taxa that: 1) have posterodorsally retracted external nares (e.g. Rhacheosaurini), 2) lack a midline premaxillary posterior process (e.g. Iharkutosuchus*) or 3) have the maxillae elongated and contacting along their midline (e.g. Thalattosuchia).* 0. posterior 1. anterior
62	**Nasals, morphology in dorsal view: (ORDERED)** *Andrade & Bertini (2008a, ch. 21); Young & Andrade (2009, ch. 160 mod.); Andrade et al. (2011, ch. 73); Young et al. (2011, ch. 160 mod.); Young et al. (2013a, ch. 9 mod.); Young et al. (2012, ch. 12 mod.); Young (2014, ch. 13 mod.); Young et al. (2016, ds 2, ch. 19 mod.); Ristevski et al. (2018, ds 2, ch. 38); Smith et al. (in review, ds 1, ch. 39); Ősi et al. (2018, ds 1, ch. 49); Foffa et al. (2019, ch.54).* *State (0) is a putative apomorphy of both Thalattosuchia and Notosuchia.* *State (2) is present in* Simosuchus*.* 0. triangular, lateral margins strongly confluent anteriorly 1. rectangular or subrectangular, lateral margins mostly parallel, or lateral margins poorly confluent anteriorly 2. triangular, lateral margins diverging anteriorly
63	**Nasal, lateroposterior processes:** *Young (2014, ch. 14); Young et al. (2016, ds 2, ch. 20); Ristevski et al. (2018, ds 2, ch. 39); Smith et al. (in review, ds 1, ch. 40); Ősi et al. (2018, ds 1, ch. 50); Foffa et al. (2019, ch.55).* *State (1) is a putative apomorphy of Metriorhynchidae.* *These processes suture with the anteroventral and anterior margin of the prefrontal, and the posterodorsal margin of the lachrymal.* 0. absent 1. present
64	**Nasals, extremely anteroposteriorly elongated posterior processes (reach past anterior rim of orbit, nearly to middle of orbit): (NEW)** *State (1) is a putative apomorphy of* Indosinosuchus potamosiamensis*.* 0. absent 1. present
65	**Nasals, fusion at maturity:** *Gasparini et al. (2006, ch. 257); Sereno & Larsson (2009, ch. 10); Hastings et al. (2010, ch. 32 mod.); Andrade et al. (2011, ch. 77); Tennant et al. (2016, ch. 65); Ristevski et al. (2018, ds 2, ch. 40); Smith et al. (in review, ds 1, ch. 41); Ősi et al. (2018, ds 1, ch. 51); Foffa et al. (2019, ch.56).* *State (1) is putative apomorphy of Dyrosauridae, but with some species having individuals with fused and unfused nasals, and some specimens with only the anterior nasals fused. Due to this variability, the character from Hastings et al. (2010) has been changed from an ordered multistate into the current binary character.* *In Thalattosuchia state (1) also occurs in* Lemmysuchus obtusidens*. As in Dyrosauridae, some individuals have fused nasals, while specimens have partially fused nasals. It is currently unclear whether the variation is ontogenetic or individual.* *State (1) is also present in Mahajangasuchidae and* Redondavenator*.* 0. absent, nasals unfused 1. present, nasals at least partially fused (note that some species have variability in this character, such as in dyrosaurids)
66	**Nasals, posterior portion at the midline:** *Nesbitt (2011, ch. 34); Young et al. (2013a, ch. 10 mod.); Young et al. (2012, ch. 13 mod.); Young (2014, ch. 15 mod.); Young et al. (2016, ds 2, ch. 21); Ristevski et al. (2018, ds 2, ch. 41); Smith et al. (in review, ds 1, ch. 42); Ősi et al. (2018, ds 1, ch. 52); Foffa et al. (2019, ch.57).* *This character tests the homology of the metriorhynchoid and (most) teleosauroid "midline trench" and "depression" features, with a similar depression (state 1) seen in "rauisuchians" and "sphenosuchians".* *The morphology of* Calsoyasuchus *might be distinct, as it has two raised ridges running parallel, at either side of the midline depression, beginning on the frontal.* *Note that in some 'sphenosuchians' (i.e.* Sphenosuchus *and* Junggarsuchus*) the raised frontal ridge can continue onto the posterior nasal, and result in this depression forming around it.*

	0. lacks a midline concavity or 'midline trench' - nasals are flat or convex 1. has a concavity at the midline, or a 'midline trench'
67	**Nasal contact with the prefrontal, in dorsal view: (*)** *Young & Andrade (2009, ch. 92); Young et al. (2011, ch. 92); Young et al. (2013a, ch. 11); Young et al. (2012, ch. 14); Young (2014, ch. 16); Young et al. (2016, ds 2, ch. 22); Ristevski et al. (2018, ds 2, ch. 42); Smith et al. (in review, ds 1, ch. 43); Ősi et al. (2018, ds 1, ch. 53); Foffa et al. (2019, ch.58).* *This character is not applicable for taxa that lack a sutural contact between the nasals and the prefrontals.* *State (1) is a putative apomorphy of the* Cricosaurus araucanensis*.* 0. irregular 1. smooth curve with a concavity directed posterolaterally
68	**Nasal-prefrontal contact:** *Young et al. (2012, ch. 15); Young (2014, ch. 17); Young et al. (2016, ds 2, ch. 23); Ristevski et al. (2018, ds 2, ch. 43); Smith et al. (in review, ds 1, ch. 44); Ősi et al. (2018, ds 1, ch. 54); Foffa et al. (2019, ch.59).* *State (1) occurs in crocodylomorphs.* 0. absent 1. present
69	**Premaxilla–maxilla lateral fossa excavating alveolus of last premaxillary tooth:** *Young & Andrade (2009, ch. 163); Young et al. (2011, ch. 163); Young et al. (2013a, ch. 12); Young et al. (2012, ch. 16); Young (2014, ch. 18); Young et al. (2016, ds 2, ch. 24); Ristevski et al. (2018, ds 2, ch. 44); Smith et al. (in review, ds 1, ch. 45); Ősi et al. (2018, ds 1, ch. 55); Foffa et al. (2019, ch.60).* 0. no 1. yes
70	**Maxilla, ventrolateral edge:** *Young & Andrade (2009, ch. 115); Young et al. (2011, ch. 115); Young et al. (2013a, ch. 13); Young et al. (2012, ch. 17); Young (2014, ch. 19); Young et al. (2016, ds 2, ch. 25); Ristevski et al. (2018, ds 2, ch. 45); Smith et al. (in review, ds 1, ch. 46); Ősi et al. (2018, ds 1, ch. 56); Foffa et al. (2019, ch.61).* 0. straight 1. single convexity 2. double convexity ('festooned')
71	**Position of the posterior-most maxillae: (ORDERED)** *Hastings et al. (2010, ch. 29 mod.); Ristevski et al. (2018, ds 2, ch. 46); Smith et al. (in review, ds 1, ch. 47); Ősi et al. (2018, ds 1, ch. 57); Foffa et al. (2019, ch.62).* *State (1+2) are putative apomorphies of Dyrosauridae.* *State (2) is a putative apomorphy of* Cerrejonisuchus. 0. anterior to, or even with, the postorbital bars 1. even with the anteroposterior mid-length of the supratemporal fenestrae 2. even with, or posterior to, the posterior margins of the supratemporal fenestrae
72	**Maxilla/jugal, presence of enlarged foramina and associated fossae on the lateral margin of the posterior maxillae and/or the anterior process of the jugal. These foramina are positioned near the maxillojugal suture. These structures are anteroposteriorly aligned (note that the foramina and associated fossae are not always contiguous):** *Ristevski et al. (2018, ds 2, ch. 47); Smith et al. (in review, ds 1, ch. 48); Ősi et al. (2018, ds 1, ch. 58); Foffa et al. (2019, ch.63).* *State (1) occurs in goniopholidids and most tethysuchians (in dyrosaurids the foramen is only present on the jugal). Note that the anterior position of the 'maxillary depressions' in* Calsoyasuchus *are not consistent with this character.* 0. absent 1. present
73	**Posterior maxilla, presence of lateral fossa/fossae next to the alveolar margin, anterior to the jugal and ventral to the lachrymal:** *Young & Andrade (2009, ch. 135 mod.); Andrade et al. (2011, ch. 87 mod.); Young et al. (2011, ch. 135 mod.); Young et al. (2013a, ch. 14 mod.); Young et al. (2012, ch. 18 mod.); Young (2014,*

	ch. 20 mod.); Young et al. (2016, ds 2, ch. 27); Ristevski et al. (2018, ds 2, ch. 48); Smith et al. (in review, ds 1, ch. 49); Ősi et al. (2018, ds 1, ch. 59); Foffa et al. (2019, ch.64). *This character is a modification of the goniopholidid + tethysuchian enlarged foramina + associated fossae character, in which there are paired depressions on either maxilla, which are anteroposteriorly elongated, dorsoventrally high, complex and entirely supported by the maxilla. State (1) occurs in Goniopholididae.* *As noted for the maxilla/jugal presence of an enlarged foramina character, the anterior position of the 'maxillary depressions' in* Calsoyasuchus *are also not consistent with this character.* 0. absent, maxillary bony surface convex or flat 1. present
74	**Maxilla, morphology of anterior border of maxillary depressions:** *Andrade et al. (2011, ch. 90); Ristevski et al. (2018, ds 2, ch. 49); Smith et al. (in review, ds 1, ch. 50); Ősi et al. (2018, ds 1, ch. 60); Foffa et al. (2019, ch.65).* *State (1) is present within Goniopholididae (*Anteophthalmosuchus *and* Goniopholis*).* 0. shallow, anterior edge of depression usually poorly defined, or maxillary depression is absent 1. deep, anterior border always well-defined relative to dermal surface of maxilla
75	**Posterior maxilla, presence of a lateral fossa/fossae that crosses the maxillojugal suture:** *Young et al. (2016, ds 2, ch. 28 mod.); Ristevski et al. (2018, ds 2, ch. 50); Smith et al. (in review, ds 1, ch. 51); Ősi et al. (2018, ds 1, ch. 61); Foffa et al. (2019, ch.66).* *This character is a modification of the goniopholidid + tethysuchian enlarged foramina + associated fossae character, in which there are paired depressions on either maxilla-jugal, which are anteroposteriorly elongated, dorsoventrally narrow, and contiguous on both the maxilla and jugal.* *State (1) occurs in Pholidosauridae* 0. absent, maxillary bony surface convex or flat 1. present
76	**Maxilla, aligned set of large foramina extending posteroventrally from the antorbital/preorbital fossa:** *Young et al. (2013a, ch. 15 mod.); Young et al. (2012, ch. 19 mod.); Young (2014, ch. 21); Young et al. (2016, ds 2, ch. 29); Ristevski et al. (2018, ds 2, ch. 51); Smith et al. (in review, ds 1, ch. 52); Ősi et al. (2018, ds 1, ch. 62); Foffa et al. (2019, ch.67).* *State (1) is a putative apomorphy of Mr Leeds dakosaur* + Dakosaurus. 0. absent 1. present
77	**Maxilla-lachrymal, contact: (*)** *Pol (1999, ch. 145); Young & Andrade (2009, ch. 141); Young et al. (2011, ch. 141); Young et al. (2013a, ch. 16); Young et al. (2012, ch. 20); Young (2014, ch. 22); Young et al. (2016, ds 2, ch. 30); Ristevski et al. (2018, ds 2, ch. 52); Smith et al. (in review, ds 1, ch. 53); Ősi et al. (2018, ds 1, ch. 63); Foffa et al. (2019, ch.68).* *This character is not applicable for taxa that lack the antorbital/preorbital fossae.* 0. partially included in antorbital/preorbital fossa 1. completely included
78	**Lachrymal, contact with the nasal:** *Young & Andrade (2009, ch. 97); Young et al. (2011, ch. 97); Young et al. (2013a, ch. 17); Young et al. (2012, ch. 21); Young (2014, ch. 23); Young et al. (2016, ds 2, ch. 31); Ristevski et al. (2018, ds 2, ch. 53); Smith et al. (in review, ds 1, ch. 54); Ősi et al. (2018, ds 1, ch. 64); Foffa et al. (2019, ch.69).* 0. nasal only contacts the dorsal margin of the lachrymal 1. nasal primarily contacts the anterior margin of the lachrymal 2. no contact between the nasals and lachrymals
79	**Nasal-lachrymal suture, length compared to nasal-prefrontal suture (in dorsal view): (*)** *Young & Andrade (2009, ch. 136 mod.); Young et al. (2011, ch. 136 mod.); Young et al. (2013a, ch. 18 mod.); Young et al. (2012, ch. 22 mod.); Young (2014, ch. 24 mod.); Young et al. (2016, ds 2, ch. 32 mod.); Ristevski et al. (2018, ds 2, ch. 54); Smith et al. (in review, ds 1, ch. 55); Ősi et al. (2018, ds 1, ch. 65; Foffa et al. (2019, ch.70).* *Ristevski et al. (2018) added a new character state.* *This character is not applicable for taxa that lack the nasal-lachrymal contact.*

	0. short – nasolachrymal suture is approximately 60% of the nasoprefrontal suture 1. the two sutures are sub-equal (± 25%) 2. long – nasolachrymal suture is approximately twice the length of the nasoprefrontal suture (i.e. elongation of the lachrymals)
80	**Lachrymal, dorsal exposure:** *Young (2006, ch. 13); Wilkinson et al. (2008, ch. 33); Young & Andrade (2009, ch. 33); Young et al. (2011, ch. 33); Young et al. (2013a, ch. 19); Young et al. (2012, ch. 23); Young (2014, ch. 25); Young et al. (2016, ds 2, ch. 33); Ristevski et al. (2018, ds 2, ch. 55); Smith et al. (in review, ds 1, ch. 56); Ősi et al. (2018, ds 1, ch. 66); Foffa et al. (2019, ch.71).* 0. present, can be observed in both dorsal and lateral view 1. absent, only visible in lateral view (lachrymal vertically orientated)
81	**Lachrymal, dorsal surface lateral development:** *Ristevski et al. (2018, ds 2, ch. 56); Smith et al. (in review, ds 1, ch. 57); Ősi et al. (2018, ds 1, ch. 67); Foffa et al. (2019, ch.72).* *This character scores a slight lachrymal overhang of the orbits. These structures are the anterior palpebral sutural attachments, which are medially positioned.* *State (1) occurs in goniopholidids + tethysuchians (except dyrosaurids,* Terminonaris *and* Oceanosuchus*)* 0. flush with the rim of the orbit 1. enlarged, extending laterally over the orbit
82	**Lachrymal, size:** *Young (2006, ch. 14); Wilkinson et al. (2008, ch. 34); Young & Andrade (2009, ch. 34); Young et al. (2011, ch. 34); Young et al. (2013a, ch. 20); Young et al. (2012, ch. 24); Young (2014, ch. 26); Young et al. (2016, ds 2, ch. 34); Ristevski et al. (2018, ds 2, ch. 57); Smith et al. (in review, ds 1, ch. 58); Ősi et al. (2018, ds 1, ch. 68); Foffa et al. (2019, ch.73).* 0. large, in lateral view at least 45% of orbit height 1. small, less than 40% of orbit height
83	**Antorbital cavity, presence:** *Clark (1994, ch. 67 mod.); Young & Andrade (2009, ch. 88 part); Andrade et al. (2011, ch. 43 mod.); Young et al. (2011, ch. 88 part); Young et al. (2013a, ch. 21 part); Young et al. (2012, ch. 23 part); Young (2014, ch. 27 part); Young et al. (2016, ds 2, ch. 35 part); Ristevski et al. (2018, ds 2, ch. 58 part); Smith et al. (in review, ds 1, ch. 59 part); Ősi et al. (2018, ds 1, ch. 69); Foffa et al. (2019, ch.74).* *Antorbital cavity (CA), internal and external antorbital fenestra (FAO, FAOE, FAOI) as in Witmer (1997). The antorbital cavity or the FAOE must not be confounded with the shallow fossa located directly in front of the eyes (=prefrontal-lachymal fossa sensu Young & Andrade, 2009; =lachrymal fossa sensu Andrade et al., 2011).* *Note that here we have modified this character so that the presence of the antorbital cavity implies in the presence of a fenestra connecting the fossa with the internal antorbital sinuses (see Fernández & Herrera, 2009). We have not created a multi-state for this character with state (2) scoring for the preorbital condition, as it is unclear whether basal thalattosuchians had the antorbital fenestrae as openings for both the antorbital sinus and for the drainage duct of the hypertrophied nasal exocrine glands.* *Note that in Teleosauroidea,* Proexochokefalos heberti, Neosteneosaurus edwardsi *and Machimosaurini (excluding* Yvridiosuchus boutilieri*) score as state (0).* 0. absent (internalised, or the opening does not communicate with the antorbital sinus) 1. present (non-internalised, and the antorbital fenestra communicates with the antorbital sinus)
84	**Antorbital/preorbital cavity:** *Young et al. (2013a, ch. 25 mod.); Young et al. (2012, ch. 31 mod.); Young (2014, ch. 33 mod.); Young et al. (2016, ds 2, ch. 41 mod.); Ristevski et al. (2018, ds 2, ch. 64 mod.); Smith et al. (in review, ds 1, ch. 65 mod.); Ősi et al. (2018, ds 1, ch. 70); Foffa et al. (2019, ch.75).* *If hypothesis 2 of Fernández & Herrera (2009) is correct, and in metriorhynchids the antorbital cavity is internalised and the opening classically referred to as the "*antorbital fenestra*" are in fact neomorphic openings for the excretion of salt; then those taxa will score as (1) here, and (0) for the previous character on the presence/absence of the antorbital cavity.* *However, should the preorbital and antorbital fenestrae be found to be homologous, the scoring distinction currently made would still be valid. Basal metriorhynchoids which have an*

	intermediate condition, with the openings communicating with both the antorbital sinus and for the drainage duct of the hypertrophied nasal exocrine glands would score as (1) for both characters. *The current character construction thus does not favour one hypothesis over the other.* *The preorbital fenestra itself is typically much smaller than realised, being a small sub-circular opening at the posterior-end of the deep fossa (where the lachrymals, nasals, jugals and maxillae converge). The deep concavity in this region can sometimes be filled with matrix, making the fenestra itself appear much larger than it really is.* *Note that in Metriorhynchidae these fenestrae are set between the lachrymal, jugal and maxilla; typically, the jugal anterior ramus overlaps the maxilla externally, such that both bones contribute to the foraminal opening anteriorly. The inclusion of the nasal to the fenestra is unclear. It could be present in* Dakosaurus *and* Maledictosuchus*, but preservation in this region makes it hard to discern.* 0. absent (internalised, or the opening communicates solely with the antorbital sinus) 1. present (non-internalised, and the antorbital/preorbital fenestra communicates with the duct to the nasal exocrine gland)
85	**Antorbital cavity, relation between external and internal antorbital/preorbital fenestrae: (*)** *Andrade et al. (2011, ch. 45 mod.); Ristevski et al. (2018, ds 1, ch. 45 mod.); Smith et al. (in review, ds 2, ch. 45 mod.); Ősi et al. (2018, ds 1, ch. 71); Foffa et al. (2019, ch.76).* *State (2) is putative apomorphy of* Eoneustes + *Metriorhynchidae.* *This character is not applicable for taxa lacking antorbital/preorbital fenestrae.* 0. external and internal fenestrae subequal or not distinguishable 1. external fenestra larger than internal fenestra, but no more than twice its area 2. external fenestra much larger than internal fenestra, or external fenestra present and internal fenestra closed
86	**Antorbital/preorbital cavity, shape: (*)** *Young (2006, ch. 19 mod.); Wilkinson et al. (2008, ch. 41); Young & Andrade (2009, ch. 41); Andrade et al. (2011, ch. 46 mod.); Young et al. (2011, ch. 41); Young et al. (2013a, ch. 23); Young et al. (2012, ch. 28); Young et al. (2016, ch. 38); Ristevski et al. (2018, ch. 61); Smith et al. (in review, ch. 62); Ősi et al. (2018, ds 1, ch. 72); Foffa et al. (2019, ch.77).* *Note that this version of the character does not score for the elongate antorbital/preorbital cavity of metriorhynchoids. That morphological complex is scored by another character, relating to the presence of a sulcus anterior to the cavity. This means however, that any metriorhynchoid in which the cavity itself is elongated (such as in the teleosauroid* Steneosaurus gracilirostris*) can be scored as state (1) for this character as well as for the sulcus character.* *This character is not applicable for taxa that lack antorbital fenestrae.* 0. subcircular, subtriangular or lozenge-shaped 1. anteroposteriorly elongated
87	**Antorbital/preorbital cavity, presence of a sulcus anterior to the cavity:** Gasparini *et al. (2006, ch. 246 mod.); Young (2006, ch. 19 mod. part); Wilkinson et al. (2008, ch. 41 mod. part); Young & Andrade (2009, ch. 41 mod. part); Andrade et al. (2011, ch. 46 mod. part); Young et al. (2011, ch. 41 mod. part); Young et al. (2013a, ch. 23 mod. part); Ősi et al. (2018, ds 1, ch. 73); Foffa et al. (2019, ch.78).* *State (1) is putative apomorphy of Metriorhynchoidea.* *In* Pelagosaurus typus *the sulcus is present (see Witmer, 1997), but it can be easily missed due to preservation as it is shallow when compared to the morphology seen in the clade* Eoneustes + *Metriorhynchidae*. *In well preserved specimens the distinction between the anterior sulcus and the external antorbital/preorbital fenestra is distinct (see* Dakosaurus andiniensis and Torvoneustes coryphaeus*).* *The external antorbital/preorbital fenestrae in the clade* Eoneustes + *Metriorhynchidae are bound by the jugal, lachrymal, nasal and maxilla. The anterior fossa continues anteriorly as a sulcus or fossa, but is largely present on the lateral surface of the maxilla.* *This character is not applicable for taxa lacking external antorbital/preorbital fenestrae.* 0. absent 1. present
88	**Antorbital cavity, size (area) of external antorbital/preorbital fenestra, relative to the orbit:**

	Clark (1994, ch. 67 mod.); Andrade et al. (2011, ch. 47 mod.); Ősi et al. (2018, ds 1, ch. 74); Foffa et al. (2019, ch.79). *States (0-1) occur in Crocodyliformes.* *State (2) occurs in non-crocodyliforms.* 0. small, being much smaller than the orbit area, or the antorbital cavity absent 1. moderately large, being at least half the diameter of the orbit 2. large, almost as large as the orbit
89	**Antorbital cavity, size (length) of internal antorbital/preorbital fenestra relative to the orbit:** *Clark (1994, ch. 67 mod.); Young & Andrade (2009, ch. 88 mod. part); Andrade et al. (2011, ch. 48); Young et al. (2011, ch. 88 mod. part); Young et al. (2013a, ch. 21 mod. part); Young et al. (2012, ch. 23 mod. part); Young (2014, ch. 27 mod. part); Young et al. (2016, ds 2, ch. 35 mod. part); Ristevski et al. (2018, ds 2, ch. 58 mod. part); Smith et al. (in review, ds 1, ch. 59 mod. part); Ősi et al. (2018, ds 1, ch. 75); Foffa et al. (2019, ch.80).* *States (0-1) occur in Crocodyliformes.* *State (2) occurs in* Junggarsuchus *(with reversals in some crocodyliforms, such as* Calsoyasuchus*).* *State (3) occurs in non-crocodyliforms.* 0. small, internal fenestra is less than 25% of the length of the orbit, or internal fenestra is absent 1. medium, internal fenestra is approximately 25-50% of the length of the orbit 2. large, internal fenestra is more than 50% of the length of the orbit 3. very large, internal fenestra approximately the same size as the orbit
90	**Antorbital cavity, nasal participation in the internal antorbital/preorbital fenestra: (*)** *Ortega et al. (2000, ch. 70 mod.); Wilkinson et al. (2008, ch. 40); Young & Andrade (2009, ch. 40); Andrade et al. (2011, ch. 49 mod.); Young et al. (2011, ch. 40); Young et al. (2013a, ch. 22 mod.); Young et al. (2012, ch. 29 mod.); Young (2014, ch. 31 mod.); Young et al. (2016, ds 2, ch. 39 mod.); Ristevski et al. (2018, ds 2, ch. 62 mod.); Smith et al. (in review, ds 1, ch. 63 mod.); Ősi et al. (2018, ds 1, ch. 76); Foffa et al. (2019, ch.81).* *State (1) is a putative apomorphy of Metriorhynchidae. It also occurs in* Calsoyasuchus *and* Gracilisuchus*.* *This character is not applicable for taxa lacking antorbital/preorbital fenestrae.* 0. absent, nasals excluded from the internal fenestra by a maxillo-lachrymal contact 1. present, nasals broadly reach the internal fenestra (or reach deep into the fossa, if the internal fenestra is closed or preorbital)
91	**Antorbital cavity, jugal participation in the external antorbital/preorbital fenestra: (*)** *Wu & Sues (1996, ch. 14 rev.); Clark et al. (2000, ch. 4); Ortega et al. (2000, ch. 71 rev.); Clark & Sues (2002, ch. 4); Sues et al. (2003, ch. 4); Clark et al. (2004, ch. 4);Young (2006, ch. 17); Wilkinson et al. (2008, ch. 39); Young & Andrade (2009, ch. 39); Andrade et al. (2011, ch. 50); Young et al. (2013a ch. 24 part); Young et al. (2012, ch. 30); Pol et al. (2013, ch. 4); Young (2014, ch. 32); Young et al. (2016, ds 2, ch. 40); Leardi et al. (2017, ch. 4);Ristevski et al. (2018, ds 2, ch. 63); Smith et al. (in review, ds 1, ch. 64); Ősi et al. (2018, ds 1, ch. 77); Foffa et al. (2019, ch.82).* *Should be scored alongside the characters regarding the antorbital fenestra, not jugal, to facilitate cross-checking of inapplicable states due to the absence of the antorbital fenestra.* *This character is not applicable for taxa lacking external antorbital/preorbital fenestrae.* 0. absent, jugal excluded from the external fenestra by a maxillary-lachrymal contact 1. present, jugal takes part in the external fenestra (or reach deep into the fossa, if the internal fenestra is closed or preorbital)
92	**Antorbital cavity, position relative to the rostrum: (*)** *Andrade et al. (2011, ch. 51 mod.); Ristevski et al. (2018, ds 2, ch. 66); Smith et al. (in review, ds 1, ch. 67); Ősi et al. (2018, ds 1, ch. 78; Foffa et al. (2019, ch.83).* *State (1) is putative apomorphy of Thalattosuchia.* *Ristevski et al. (2018) modified state (1) to say 'approximately equidistant…', as in some teleosauroids (*e.g. Mystriosaurus laurillardi, Platysuchus multiscrobiculatus*) the cavity is almost equidistant between the orbits and alveolar margin. But, these taxa still have the antorbital cavity being noticeably anterior to the orbits, as with other thalattosuchians that have not closed these cavities.* *This character is not applicable for taxa lacking external antorbital/preorbital fenestrae.*

	0. closer to the orbit than to the alveolar margin 1. closer to the alveolar margin than to the orbit, or approximately equidistant (but with the cavity still noticeably anterior to the orbit)
93	**Antorbital cavity, position relative to the orbit: (*)** *Andrade et al. (2011, ch. 52); Ősi et al. (2018, ds 1, ch. 79); Foffa et al. (2019, ch.84).* *This character is not applicable for taxa lacking antorbital/preorbital fenestrae.* 0. close to the orbit, with lachrymal narrow between orbit and antorbital cavity 1. distant to the orbit, with lachrymal wide between orbit and antorbital cavity
94	**Prefrontal-lachrymal fossae:** *Young & Andrade (2009, ch. 150); Young et al. (2011, ch. 150); Young et al. (2013a, ch. 27); Young et al. (2012, ch. 33); Young (2014, ch. 35); Young et al. (2016, ds 2, ch. 43); Ristevski et al. (2018, ds 2, ch. 67); Smith et al. (in review, ds 1, ch. 68); Ősi et al. (2018, ds 1, ch. 80); Foffa et al. (2019, ch.85).* *Andrade et al. (2011, ch. 30) scores for a similar character, namely the presence of a lachrymal crest anterior to the orbit.* *The prefrontal-lachrymal fossa (sensu Young & Andrade, 2009) refers to a shallow depression immediately anterior to the orbit, present on both the prefrontal and lachrymal. It is situated posterior to the preorbital fenestra, and never contacts the preorbital fossa. There is a crest within this fossa that is present along the prefrontal-lachrymal contact (scored for by Andrade et al. 2011, ch. 30).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. absent 1. present, with ridge following the sutural contact between these elements

Skull roof (Ch. 95 – 148; 10.997% of characters)

[skull roof proportions and arrangement, supratemporal fenestrae, dermatocranial bones (= ossa præfrontalia, os frontale, ossa postorbitalia, ossa squamosal and os parietale)]

#	Description
95	**Supratemporal skull roof, dorsal surface:** *Clark (1994, ch. 24); Young (2006, ch. 10 mod.); Wilkinson et al. (2008, ch. 29); Young & Andrade (2009, ch. 29); Andrade et al. (2011, ch. 118); Young et al. (2011, ch. 29); Young et al. (2013a, ch. 28); Young et al. (2012, ch. 34); Young (2014, ch. 36); Young et al. (2016, ds 2, ch. 44); Ristevski et al. (2018, ds 2, ch. 68); Smith et al. (in review, ds 1, ch. 69); Ősi et al. (2018, ds 1, ch. 81); Foffa et al. (2019, ch.86).* *State (1) is a putative apomorphy of Crocodyliformes (reversal in Thalattosuchia).* 0. surface complex 1. flat skull table present, formed by flattened and levelled surfaces of frontal, postorbital, squamosal and parietal
96	**Posterior skull table:** *Young & Andrade (2009, ch. 99); Young et al. (2011, ch. 99); Young et al. (2013a, ch. 29); Young et al. (2012, ch. 35); Young (2014, ch. 37); Young et al. (2016, ds 2, ch. 45); Ristevski et al. (2018, ds 2, ch. 69); Smith et al. (in review, ds 1, ch. 70); Ősi et al. (2018, ds 1, ch. 82); Foffa et al. (2019, ch.87).* *Note that* Sphagesaurus *scores differently in this character, and for the preceding character.* 0. non-planar (squamosal ventral to horizontal level of postorbital and parietal) 1. planar (postorbital, squamosal, and parietal on same horizontal plane)
97	**Cranial table width relative to ventral portion of skull:** *Young & Andrade (2009, ch. 113); Young et al. (2011, ch. 113); Young et al. (2013a, ch. 30); Young et al. (2012, ch. 36); Young (2014, ch. 38); Young et al. (2016, ds 2, ch. 46); Ristevski et al. (2018, ds 2, ch. 70); Smith et al. (in review, ds 1, ch. 71); Ősi et al. (2018, ds 1, ch. 83); Foffa et al. (2019, ch. 88).* 0. nearly as wide 1. narrower

98	**Supratemporal skull roof, dorsal curvature and elongation of squamosal prongs, at maturity:** *Brochu (1999, ch. 140); Young & Andrade (2009, ch. 148); Andrade et al. (2011, ch. 119); Young et al. (2011, ch. 148); Young et al. (2013a, ch. 31); Young et al. (2012, ch. 37); Young (2014, ch. 39); Young et al. (2016, ds 2, ch. 47); Ristevski et al. (2018, ds 2, ch. 71); Smith et al. (in review, ds 1, ch. 72); Ősi et al. (2018, ds 1, ch. 84); Foffa et al. (2019, ch. 89).* 0. short posterolateral process of the squamosal 1. mature skull table with nearly horizontal sides; significant posterolateral process of the squamosal
99	**Supratemporal fenestrae, presence:** *Ősi et al. (2018, ds 1, ch. 85); Foffa et al. (2019, ch.90).* *State (1) occurs in Gobiosuchidae.* *State (2) is a putative autapomorphy of* Iharkutosuchus makadii*.* 0. present as an evident fenestra 1. presence variable during ontogeny, with the fenestrae possibly open during early ontogenetic stages (only closing later), or with there being a distinct 'depression' in the supratemporal region with the fenestrae themselves being reduced to a small foramen or completely closed 2. absent throughout ontogeny (i.e. supratemporal fenestrae are closed by the frontal and parietal suturing from an early ontogenetic state, with no 'depression' in the region)
100	**Supratemporal fossa, presence of "infratemporal flanges": (*)** *Young & Andrade (2009, ch. 142 mod.); Nesbitt (2011, ch. 144 mod.); Young et al. (2011, ch. 142); Young et al. (2013a, ch. 36); Young et al. (2012, ch. 44 mod.); Young (2014, ch. 46 mod.); Young et al. (2016, ds 2, ch. 48); Ristevski et al. (2018, ds 2, ch. 72); Smith et al. (in review, ds 1, ch. 73); Ősi et al. (2018, ds 1, ch. 86); Foffa et al. (2019, ch. 91).* *This character tests the homology of metriorhynchid "infratemporal flanges" and the teleosauroid anteromedial supratemporal fossae, with the anterior extension seen in basal crocodylomorphs.* *State (0) is a putative apomorphy of Crocodyliformes (reversal in Thalattosuchia)* *Note, this character scores for the 'flat platform' formed by the frontal, and not the concavity that can form in neosuchians.* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. absent anterior to, and anteromedially to, the supratemporal fenestra 1. present anterior to, or anteromedially to, the supratemporal fenestra
101	**Supratemporal fossa, anterior margin in dorsal view: (*)** *Young (2006, ch. 9 mod.); Wilkinson et al. (2008, ch. 28); Young & Andrade (2009, ch. 28); Young et al. (2011, ch. 28); Young et al. (2013a, ch. 32); Young et al. (2012, ch. 38); Young (2014, ch. 40); Young et al. (2016, ds 2, ch. 49); Ristevski et al. (2018, ds 2, ch. 73); Smith et al. (in review, ds 1, ch. 74); Ősi et al. (2018, ds 1, ch. 87); Foffa et al. (2019, ch. 92).* *This character was designed to quantify the anterior extent of the supratemporal fossae. In Metriorhynchidae, the fossae begin to invade the dorsal surface of the orbital region. In* Dakosaurus*,* Purranisaurus potens, Cricosaurus saltillensis, *and* C. schroederi *the supratemporal fossae extend as far anteriorly as the minimum interorbital distance (state 3).* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. anterior margin terminates posterior to the postorbital 1. anterior margin terminates between the anterior and posterior points of the frontal-postorbital suture 2. anterior margin terminates level to the postorbital anterior margin 3. anterior margin projects more anteriorly than the postorbital and reaches the interorbital minimum distance
102	**Supratemporal fossae, overall shape: (*)**

	Young & Andrade (2009, ch. 110 + 120 mod. part); Andrade et al. (2011, ch. 111 mod.); Young et al. (2011, ch. 110 + 120 mod. part); Young et al. (2013a, ch. 33 mod. part); Young et al. (2012, ch. 39 + 40 + 41 mod.); Young (2014, ch. 41 + 42 + 43); Young et al. (2016, ds 2, ch. 50 + 51 + 52 mod.); Ristevski et al. (2018, ds 2, ch. 74); Smith et al. (in review, ds 1, ch. 75); Ősi et al. (2018, ds 1, ch. 88); Foffa et al. (2019, ch. 93). *This character is an amalgam of character 111 from Andrade et al. (2011), and characters 50, 51 and 52 from Young et al. (2016, ds 2).* *In Thalattosuchia, state (1) is a putative apomorphy for* Teleosaurus cadomensis *and* Maledictosuchus ricalensis. *State (2) occurs in* Elosuchus *and* Vectisuchus*.* *In Thalattosuchia, state (4) is a putative apomorphy of* Cricosaurus araucanensis *and* C. vignaudi. *State (5) is a putative apomorphy of Machimosaurini*. *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. longitudinal ellipsoid/sub-rectangular (anteroposterior axis more than 10% longer than the lateromedial axis) 1. square-shaped to sub-rectangular (anteroposterior axis more than 10% longer than the lateromedial axis) 2. transverse triangle-shaped, with the axis converging medially (lateromedial axis more than 10% longer than the anteroposterior axis 3. circular to sub-circular 4. triangle-shaped, axis converging medially 5. parallelogram: lateral and medial margins, and anterior and posterior margins are sub-parallel
103	**Supratemporal fossa/fenestra, anterior margin shape, anterolateral expansion: (*)** *Ristevski et al. (2018, ds 2, ch. 75); Smith et al. (in review, ds 1, ch. 76); Ősi et al. (2018, ds 1, ch. 89); Foffa et al. (2019, ch. 94).* *State (1) occurs in the teleosauroids* Mycterosuchus nasutus*, the Chinese teleosauroid,* Indosinosuchus *species,* Platysuchus multiscrobiculatus*,* Teleosaurus cadomensis*,* Bathysuchus megarhinus*,* Aeolodon priscus *and* Mystriosaurus laurillardi. *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. no anterolateral expansion of the supratemporal fenestrae/fossae 1. anterior margin of the supratemporal fossae are noticeably inclined anterolaterally, such that the anterolateral corners of the supratemporal fossae are noticeably more anterior than the anteromedial corners of the supratemporal fossae
104	**Supratemporal fenestra, overall anteroposterior elongation: (*)** *Ristevski et al. (2018, ds 2, ch. 76); Smith et al. (in review, ds 1, ch. 77); Ősi et al. (2018, ds 1, ch. 90); Foffa et al. (2019, ch. 95).* *State (1) occurs in derived teleosauroids.* *This character is not homologous to the anteroposterior elongation of the supratemporal fenestrae in other clades, as it is caused by the extreme anteroposterior elongation of the proötics, laterosphenoids, postorbital posterior processes, parietal anterior process and frontal posterior process.* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. length is either less than, or approximately sub-equal to the anterior width 1. length is twice as long as the anterior width, or more. In *Machimosaurus*, the width of the supratemporal fenestrae increases, however the extreme elongation of the bones is still present.
105	**Supratemporal fenestra, overall anteroposterior elongation: (*)** *Ristevski et al. (2018, ds 2, ch. 77); Smith et al. (in review, ds 1, ch. 78); Ősi et al. (2018, ds 1, ch. 91); Foffa et al. (2019, ch. 96).* *State (1) occurs in dyrosaurids.* *This character is not homologous to the anteroposterior elongation of the supratemporal fenestrae in teleosauroids, as it is caused by the anteroposterior*

	elongation of the laterosphenoids, postorbital posterior processes, squamosal anterior processes and parietal anterior process. *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. length is either less than, or approximately sub-equal to the width at the middle of the fenestra (± 25%) 1. length is greater than the width of the fenestra (greater than 125%)
106	**Supratemporal fenestra, in dorsal view, size relative to orbits: (*)** *Young (2006, ch. 11); Wilkinson et al. (2008, ch. 30); Young & Andrade (2009, ch. 30); Young et al. (2011, ch. 30); Young et al. (2013a, ch. 34); Young et al. (2012, ch. 42); Young (2014, ch. 44); Young et al. (2016, ds 2, ch. 53); Ristevski et al. (2018, ds 2, ch. 78); Smith et al. (in review, ds 1, ch. 79); Ősi et al. (2018, ds 1, ch. 92); Foffa et al. (2019, ch. 97).* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. longer in length than the orbit (supratemporal length 110% or more of orbit length) 1. subequal in length as the orbit (± 5%) 2. smaller than the orbits (supratemporal length less than 90% of orbit length)
107	**Supratemporal fenestra, in dorsal view, posterior limit: (*)** *Wilkinson et al. (2008, ch. 31 mod.); Young & Andrade (2009, ch. 31 mod.); Young et al. (2011, ch. 31 mod.); Young et al. (2013a, ch. 35 mod.); Young et al. (2012, ch. 43); Young (2014, ch. 45); Young et al. (2016, ds 2, ch. 54); Ristevski et al. (2018, ds 2, ch. 79); Smith et al. (in review, ds 1, ch. 80); Ősi et al. (2018, ds 1, ch. 93); Foffa et al. (2019, ch. 98).* *State (2) is a putative apomorphy of the* Dakosaurus + Plesiosuchus *sub-clade.* *Note, scoring of this character should be done carefully, it may not be possible to score for skulls that have suffered taphonomic dorsoventral compression/shearing.* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. terminates well before the posterior-most point of the parietal 1. either terminates near the posterior-most point of the parietal or exceeds it, but never reaches the supraoccipital 2. more posterior than intertemporal bar
108	**Supratemporal fenestra/fossae, posterior margin in dorsal view: (*)** *Jouve et al. (2005b, ch. 10 mod.), Jouve (2005, ch. 6 mod.), Jouve et al. (2008, ch. 10 mod.), Hastings et al. (2010, ch. 10 mod.); Ristevski et al. (2018, ds 2, ch. 80); Smith et al. (in review, ds 1, ch. 81); Ősi et al. (2018, ds 1, ch. 94); Foffa et al. (2019, ch. 99).* *State (1) occurs in derived dyrosaurids.* *This character is not applicable for taxa that lack the 'skull table' temporal morphotype, or taxa that lack supratemporal fenestrae.* 0. supratemporal fenestral posterior wall largely vertical and barely visible in dorsal view 1. supratemporal fenestral posterior wall posterodorsally inclined, creating a posterior fossa that is visible in dorsal view
109	**Supratemporal arch, medial margin in dorsal view: (*)** *Young & Andrade (2009, ch. 91); Young et al. (2011, ch. 91); Young et al. (2013a, ch. 37); Young et al. (2012, ch. 45); Young (2014, ch. 47); Young et al. (2016, ds 2, ch. 55); Ristevski et al. (2018, ds 2, ch. 81); Smith et al. (in review, ds 1, ch. 82); Ősi et al. (2018, ds 1, ch. 95); Foffa et al. (2019, ch. 100).* *State (1) is a putative apomorphy of* 'Dakosaurus' lissocephalus + Cricosaurus. *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. not convex 1. convex
110	**Supratemporal arch, dorsal margin in lateral view: (*)** *Young & Andrade (2009, ch. 98); Young et al. (2011, ch. 98); Young et al. (2013a, ch. 38); Young et al. (2012, ch. 46); Young (2014, ch. 48); Young et al. (2016, ds2, ch. 56); Ristevski et al. (2018, ds 2, ch. 82); Smith et al. (in review, ds 1, ch. 83); Ősi et al. (2018, ds 1, ch. 96); Foffa et al. (2019, ch. 101).*

	This character is not applicable for taxa lacking supratemporal fenestrae. 0. concave 1. straight 2. convex
111	**Supratemporal arch, width in dorsal view: (*)** *Jouve et al. (2005b, ch. 16 mod.), Jouve et al. (2008, ch. 16 mod.), Hastings et al. (2010, ch. 11 mod.); Ristevski et al. (2018, ds 2, ch. 83); Smith et al. (in review, ds 1, ch. 84); Ősi et al. (2018, ds 1, ch. 97); Foffa et al. (2019, ch. 102).* *State (1) scores the thin supratemporal arches of Dyrosauridae (with some reversals).* *This character is not applicable for taxa that lack the 'skull table' temporal morphotype, or taxa that lack supratemporal fenestrae.* 0. thick 1. thin
112	**Prefrontal, dorsal surface lateral development: (ORDERED)** *Gasparini et al. (2006, ch. 247 mod.); Young (2006, ch. 2 mod.); Wilkinson et al. (2008, ch. 12); Jouve (2009, ch. 255 mod.); Young & Andrade (2009, ch. 12); Andrade et al. (2011, ch. 125 mod.); Young et al. (2011, ch. 12); Young et al. (2013a, ch. 39); Young et al. (2012, ch. 47); Young (2014, ch. 49); Young et al. (2016, ds 2, ch. 57); Ristevski et al. (2018, ds 2, ch. 84); Smith et al. (in review, ds 1, ch. 85); Ősi et al. (2018, ds 1, ch. 98); Foffa et al. (2019, ch. 103).* *The transverse development of the prefrontal is a classic characteristic of Metriorhynchidae.* *State (1) is a putative apomorphy of* Eoneustes*, however it could be more widespread among basal metriorhynchoids.* *State (2) is a putative apomorphy of Metriorhynchidae.* 0. reduced, flush with the rim of the orbit 1. incipient enlargement (extending laterally over the orbit by approximately 5% of its width) 2. enlarged (extending laterally over the orbit by more than 15% of its width)
113	**Prefrontal, lateral development relative to the posterolateral corner of the supratemporal fossa in dorsal view: (*)** *Wilkinson et al. (2008, ch. 13 mod.); Young & Andrade (2009, ch. 13 mod.); Young et al. (2011, ch. 13 mod.); Young et al. (2013a, ch. 40); Young et al. (2012, ch. 48); Young (2014, ch. 50); Young et al. (2016, ds 2, ch. 58); Ristevski et al. (2018, ds 2, ch. 85); Smith et al. (in review, ds 1, ch. 86); Ősi et al. (2018, ds 1, ch. 99); Foffa et al. (2019, ch. 104)..* *This character is not applicable for taxa lacking supratemporal fenestrae.* 0. prefrontal does not expand laterally so that it is in the same plane as the posterolateral corner of the supratemporal fossa 1. prefrontal expands further laterally than the posterolateral corner of the supratemporal fossa
114	**Prefrontal, shape in dorsal view:** *Wilkinson et al. (2008, ch. 14 mod. part); Young & Andrade (2009, ch. 14 mod. part); Young et al. (2011, ch. 14 mod. part); Young et al. (2013a, ch. 41 mod. part); Young et al. (2012, ch. 49); Young (2014, ch. 51); Young et al. (2016, ds 2, ch. 59); Ristevski et al. (2018, ds 2, ch. 86); Smith et al. (in review, ds 1, ch. 87); Ősi et al. (2018, ds 1, ch. 100); Foffa et al. (2019, ch. 105).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. quadrilateral with irregular outline 1. teardrop-shaped
115	**Prefrontal, morphology of the lateral border in dorsal view: (*)** *Wilkinson et al. (2008, ch. 14 mod. part); Young & Andrade (2009, ch. 14 mod. part); Young et al. (2011, ch. 14 mod. part); Young et al. (2013a, ch. 41 mod. part); Young et al. (2012, ch. 50); Young (2014, ch. 52); Young et al. (2016, ds 2, ch. 60); Ristevski et al. (2018, ds 2, ch. 87); Smith et al. (in review, ds 1, ch. 88); Ősi et al. (2018, ds 1, ch. 101); Foffa et al. (2019, ch. 106).*

	This character describes the shape of the prefrontal in Metriorhynchidae, and thus is not applicable for taxa that do not have the lateral expansion of the prefrontal. Eoneustes*, metriorhynchines and basal geosaurines score as state (0).* *State (1) is a putative apomorphy of Geosaurini.* *State (2) is a putative apomorphy of* Dakosaurus *(a modification of the Geosaurini condition).* 0. continuous convex curve, inflexion point approximately 80–90 degree angle from the anteroposterior axis of the skull 1. continuous convex curve, inflexion point approximately 60–70 degree angle from the anteroposterior axis of the skull 2. continuous convex curve, inflexion point approximately 50 degree angle from the anteroposterior axis of the skull
116	**Prefrontal, dimensions in dorsal view:** *Wilkinson et al. (2008, ch. 15); Young & Andrade (2009, ch. 15); Young et al. (2011, ch. 15); Young et al. (2013a, ch. 42); Young et al. (2012, ch. 51); Young (2014, ch. 53); Young et al. (2016, ds2, ch. 61); Ristevski et al. (2018, ds 2, ch. 88); Smith et al. (in review, ds 1, ch. 89); Ősi et al. (2018, ds 1, ch. 102); Foffa et al. (2019, ch. 107).* 0. longer than wide 1. length/width is subequal (± 5%)
117	**Prefrontal, anterior to the orbits:** *Wilkinson et al. (2008, ch. 16); Young & Andrade (2009, ch. 16); Young et al. (2011, ch. 16); Young et al. (2013a, ch. 43); Young et al. (2012, ch. 52); Young (2014, ch. 54); Young et al. (2016, ds 2, ch. 62); Ristevski et al. (2018, ds 2, ch. 89); Smith et al. (in review, ds 1, ch. 90); Ősi et al. (2018, ds 1, ch. 103); Foffa et al. (2019, ch. 108).* 0. elongate, oriented parallel to antero-posterior axis of the skull 1. short and broad
118	**Prefrontal, nasal-prefrontal suture has a pronounced, rectangular 'concavity' (directed posteriorly):** *Young & Andrade (2009, ch. 93); Young et al. (2011, ch. 93); Young et al. (2013a, ch. 44); Young et al. (2012, ch. 53); Young (2014, ch. 55); Young et al. (2016, ds 2, ch. 63); Ristevski et al. (2018, ds 2, ch. 90); Smith et al. (in review, ds 1, ch. 91); Ősi et al. (2018, ds 1, ch. 104); Foffa et al. (2019, ch. 109).* *State (1) is a putative apomorphy of* Eoneustes*.* 0. absent 1. present
119	**Prefrontal, nasal-prefrontal suture has a posteriorly directed 'V'-shape:** *Young & Andrade (2009, ch. 140); Young et al. (2011, ch. 140); Young et al. (2013a, ch. 45); Young et al. (2012, ch. 54); Young (2014, ch. 56); Young et al. (2016, ds 2, ch. 64); Ristevski et al. (2018, ds 2, ch. 91); Smith et al. (in review, ds 1, ch. 92); Ősi et al. (in review, ds 1, ch. 105); Foffa et al. (2019, ch. 110).* *State (1) is a putative autapomorphy of* Cricosaurus macrospondylus*.* 0. absent 1. present
120	**Frontal, dorsal surface along the midline:** *Nesbitt (2011, ch. 42 mod.); Young et al. (2016, ds 2, ch. 66); Ristevski et al. (2018, ds 2, ch. 92); Smith et al. (in review, ds 1, ch. 93); Ősi et al. (2018, ds 1, ch. 106); Foffa et al. (2019, ch. 111).* *State (0) is a putative apomorphy of Crocodyliformes (although there is a reversal in numerous neosuchian clades)* 0. flat 1. an incomplete longitudinal ridge along the midline 2. a longitudinal ridge that proceeds along the entire length of the midline

121	**Frontal, dorsal surface:** *Young et al. (2016, ds 2, ch. 67); Ristevski et al. (2018, ds 2, ch. 93); Smith et al. (in review, ds 1, ch. 94); Ősi et al. (2018, ds 1, ch. 107); Foffa et al. (2019, ch. 112).* *State (1) occurs in* Hesperosuchus *cf.* agilis, Dromicosuchus grallator, *and among many tethysuchians (except derived dyrosaurids).* 0. slightly convex or flat 1. concave, with the medial borders of the orbit upturned
122	**Frontal, anteromedial process length: (*)** *Jouve et al. (2008, ch. 31 mod.), Hastings et al. (2010, ch. 38 mod.); Ristevski et al. (2018, ds 2, ch. 94); Smith et al. (in review, ds 1, ch. 95); Ősi et al. (2018, ds 1, ch. 108); Foffa et al. (2019, ch. 113).* *This character is not applicable for* Anthracosuchus *and* Cerrejonisuchus *as the anterior region of the frontal is elongated and the prefrontals are reduced (i.e. there is no elongation of the anteromedial process).* 0. the anteromedial process is approximately level to, or slightly posterior to, the prefrontals 1. the anteromedial process is noticeably posterior to the prefrontals
123	**Frontal, anteromedial process:** *Young et al. (2016, ds 2, ch. 68); Ristevski et al. (2018, ds 2, ch. 95); Smith et al. (in review, ds 1, ch. 96); Ősi et al. (2018, ds 1, ch. 109); Foffa et al. (2019, ch. 114).* *State (1) is a putative apomorphy of Sebecia, also occurs in some basal dyrosaurids, bernissartiids and hylaeochampsids.* 0.frontal anteromedial process has an acute anterior margin, which separates the left and right nasals along their posterior margin 1. frontal anteromedial process lacks an acute anterior margin, with the nasal posterior margin with the frontal being either transversely straight, or is slightly convex or concave (in taxa where the prefrontals expand anterolaterally, there can sometimes be posteromedial processes of the nasals)
124	**Frontal, anteromedial process shape and length relative to nasals: (NEW)** *State (0) occurs in* Clovesuurdameredeor stephani. 0. anterior projection of frontal is mediolaterally broad and does not extend far anteriorly past anterior orbital rim into nasals 1. anterior projection of frontal is mediolaterally thin and extends anteriorly past anterior orbital rim into nasals
125	**Frontal, in dorsal view, anterolateral projections between nasals and prefrontals: (NEW)** *State (1) is a putative apomorphy of* Machimosaurus buffetauti. 0. absent 1. present
126	**Frontal, contribution to the intertemporal bar: (*)** *Smith et al. (in review, ds 1, ch. 97); Ősi et al. (2018, ds 1, ch. 110); Foffa et al. (2019, ch. 115).* *This character is not applicable for taxa that lack supratemporal fenestrae.* *Note that in many crocodyliforms the frontal only forms the very anterior region of the intersupratemporal fenestral area. We only score taxa as state (1) if the frontal is clearly anterior to the bar.* *State (1) occurs in* Protosuchus*,* Mahajangasuchus*,* Elosuchus*,* Vectisuchus*,* Chalawan thailandicus*,* Sarcosuchus*, and Crocodylia.* 0. frontal contributes to the anterior part of the intertemporal bar 1. frontal is excluded from the intertemporal bar, with the bar being solely composed by the parietal
127	**Frontal, angle between posteromedial and posterolateral processes: (*)** *Wilkinson et al. (2008, ch. 26 mod.); Young & Andrade (2009, ch. 26 mod.); Andrade et al. (2011, ch. 98 mod.); Young et al. (2011, ch. 26); Young et al. (2013a, ch. 47); Young et al. (2012, ch. 56); Young (2014, ch. 58); Young et al. (2016, ds 2, ch. 69); Ristevski et al. (2018, ds 2, ch. 96); Smith et al. (in review, ds 1, ch. 98); Ősi et al. (2018, ds 1, ch. 111); Foffa et al. (2019, ch. 116).*

	See diagrammatic explanation for this character in Wilkinson et al. (2008: p.1311, Fig. 4). *This character is not applicable for taxa that lack supratemporal fenestrae (which help form the distinct posterior processes of the frontal).* 0. approximately 90 degree angle, or obtuse 1. approximately 70–60 degree angle 2. approximately 45 degree angle, or more acute
128	**Frontal, minimum width between orbits in dorsal view compared to the supratemporal fossa: (*)** *Young & Andrade (2009, ch. 121); Young et al. (2011, ch. 121); Young et al. (2013a, ch. 48); Young et al. (2012, ch. 57); Young (2014, ch. 59); Young et al. (2016, ds 2, ch. 70); Ristevski et al. (2018, ds 2, ch. 97); Smith et al. (in review, ds 1, ch. 99); Ősi et al. (2018, ds 1, ch. 112); Foffa et al. (2019, ch. 117).* *This character is not applicable for taxa that lack supratemporal fenestrae.* 0. greater than, or equal to, the width of one supratemporal fossa and the intertemporal bar 1. subequal to width of one supratemporal fossa
129	**Frontal, minimum width between orbits in dorsal view compared to the orbits:** *Young & Andrade (2009, ch. 137); Young et al. (2011, ch. 137); Young et al. (2013a, ch. 49); Young et al. (2012, ch. 58); Young (2014, ch. 60); Young et al. (2016, ds 2, ch. 71); Ristevski et al. (2018, ds 2, ch. 98); Smith et al. (in review, ds 1, ch. 100); Ősi et al. (2018, ds 1, ch. 113); Foffa et al. (2019, ch. 118).* 0. broader than orbital width 1. subequal with orbital width 2. narrower than orbital width
130	**Frontal-parietal, between supratemporal fossa in dorsal view (intertemporal bar): (*)** *Wilkinson et al. (2008, ch. 2); Young & Andrade (2009, ch. 2); Young et al. (2011, ch. 2); Young et al. (2013a, ch. 50); Young et al. (2012, ch. 59); Young (2014, ch. 61); Young et al. (2016, ds 2, ch. 72); Ristevski et al. (2018, ds 2, ch. 99); Smith et al. (in review, ds 1, ch. 101); Ősi et al. (2018, ds 1, ch. 114); Foffa et al. (2019, ch. 119).* *This character is not applicable for taxa that lack supratemporal fenestrae (as there is no intertemporal bar).* 0. frontal and parietal subequal in width (± 5%) 1. frontal width is wider than the parietal. Can be extreme (greater than 75%)
131	**Frontal-postorbital suture: (*)** *Wilkinson et al. (2008, ch. 27 mod.); Young & Andrade (2009, ch. 27 mod.); Young et al. (2011, ch. 27); Young et al. (2013a, ch. 51); Young et al. (2012, ch. 60); Young (2014, ch. 62); Young et al. (2016, ds 2, ch. 73); Ristevski et al. (2018, ds 2, ch. 100); Smith et al. (in review, ds 1, ch. 102); Ősi et al. (2018, ds 1, ch. 115); Foffa et al. (2019, ch. 120).* *This character is not applicable for taxa that lack supratemporal fenestrae (as there is no intertemporal bar).* 0. level with the intertemporal bar 1. lower than the intertemporal bar
132	**Frontal-postorbital suture, in dorsal view:** *Wilkinson et al. (2008, ch. 3 mod.); Young & Andrade (2009, ch. 3 mod.); Hastings et al. (2010, ch. 40 mod.); Young et al. (2011, ch. 3 mod.); Young et al. (2013a, ch. 52 mod.); Young et al. (2012, ch. 61 mod.); Young (2014, ch. 63 mod.); Young et al. (2016, ds 2, ch. 74 mod.); Ristevski et al. (2018, ds 2, ch. 101); Smith et al. (in review, ds 1, ch. 103); Ősi et al. (i2018, ds 1, ch. 116); Foffa et al. (2019, ch. 121).* *This character is an amalgam of the Hastings et al. (2010, ch. 40) and Young et al. (2016, ds 2, ch. 74) characters.* *State (1) is a putative apomorphy of Metriorhynchidae.* *State (2) scores the dyrosaurid morphotype.* 0. irregular and straight or gently curved

	1. frontal overlaps the postorbital, creating a 'V'-shape directed posteriorly. 2. strongly interdigitating in dorsal view (largely in one plane)
133	**Postorbital, shape in dorsal view:** *Young & Andrade (2009, ch. 118); Young et al. (2011, ch. 118); Young et al. (2013a, ch. 53); Young et al. (2012, ch. 62); Young (2014, ch. 64); Young et al. (2016, ds 2, ch. 75); Ristevski et al. (2018, ds 2, ch. 102); Smith et al. (in review, ds 1, ch. 104); Ősi et al. (2018, ds 1, ch. 117); Foffa et al. (2019, ch. 122).* 0. the outer margin is convex where the postorbital curves posteriorly forming the supratemporal arch 1. forms a 90 degree angle 2. anterior extension from the corner
134	**Postorbital, anterolateral extension:** *Young & Andrade (2009, ch. 138); Young et al. (2011, ch. 138); Young et al. (2013a, ch. 54); Young et al. (2012, ch. 63); Young (2014, ch. 65); Young et al. (2016, ds 2, ch. 76); Ristevski et al. (2018, ds 2, ch. 103); Smith et al. (in review, ds 1, ch. 105); Ősi et al. (2018, ds 1, ch. 118); Foffa et al. (2019, ch. 123).* *State (1) of this character, and state (2) of the character "anterior extension from the postorbital corner" do not necessarily occur in the same taxon (e.g.* Oceanosuchus*).* 0. small or absent 1. very large, appearing in lateral view to contact the dorsal surface of the jugal
135	**Postorbital and squamosal, relative lengths in dorsal view:** *Young (2006, ch. 15); Wilkinson et al. (2008, ch. 37); Young & Andrade (2009, ch. 37); Young et al. (2011, ch. 37); Young et al. (2013a, ch. 55); Young et al. (2012, ch. 64); Young (2014, ch. 66); Young et al. (2016, ds 2, ch. 77); Ristevski et al. (2018, ds 2, ch. 104); Smith et al. (in review, ds 1, ch. 106); Ősi et al. (2018, ds 1, ch. 119); Foffa et al. (2019, ch. 124).* *State (1) is a putative apomorphy of Thalattosuchia.* 0. squamosal is longer 1. postorbital is longer
136	**Supratemporal arch (= upper temporal bar), relative participation of the postorbital:** *Ortega et al. (2000, ch. 33 mod.); Andrade et al. (2011, ch. 151); Ristevski et al. (2018, ds 2, ch. 105); Smith et al. (in review, ds 1, ch. 107); Ősi et al. (2018, ds 1, ch. 120); Foffa et al. (2019, ch. 125).* *Young & Andrade (2009, ch. 127); Young et al. (2011, ch. 127); Young et al. (2013a, ch. 57); Young et al. (2012, ch. 66); Young (2014, ch. 68) and Young et al. (2016, ch. 79) score for the same morphology, however they used the squamosal contribution to the supratemporal arch.* *State (1) is putative apomorphy of Thalattosuchia.* *Note that a similar morphology also evolves in some derived dyrosaurids (elongation of the postorbital posterior processes). In these taxa however, the character relating to the relative participation of the postorbital is not affected (i.e. the squamosal in dorsal view is still longer anteroposteriorly than the postorbital). The postorbital being longer overall, and makes a greater proportional contribution to the supratemporal arch than the squamosal, only co-occurs in Thalattosuchia.* 0. small, postorbital represents approximately 30% of the bar 1. extensive, postorbital represents approximately 50% (or more) of the bar
137	**Posterior margin of the squamosal lateral to post-temporal fenestrae:** *Jouve et al. (2005b, ch. 29), Jouve et al. (2008, ch. 29), Hastings et al. (2010, ch. 48); Ristevski et al. (2018, ds 2, ch. 106); Smith et al. (in review, ds 1, ch. 108); Ősi et al. (2018, ds 1, ch. 121); Foffa et al. (2019, ch. 126).* *State (1) occurs in derived dyrosaurids.* 0. straight 1. anteriorly concave
138	**Squamosal, projects further posteriorly than the occipital condyle:** *Young & Andrade (2009, ch. 125); Young et al. (2011, ch. 125); Young et al. (2013a, ch. 56); Young et al. (2012, ch. 65); Young (2014, ch. 67); Young et al.*

	(2016, ds 2, ch. 78); Ristevski et al. (2018, ds 2, ch. 107); Smith et al. (in review, ds 1, ch. 109); Ősi et al. (2018, ds 1, ch. 122); Foffa et al. (2019, ch. 127). 0. no 1. yes
139	**Squamosal dorsolateral edge, longitudinal groove:** *Young & Andrade (2009, ch. 112 part); Nesbitt (2011, ch. 53); Young et al. (2011, ch. 112 part); Young et al. (2013a, ch. 58 part); Young et al. (2012, ch. 67 part); Young (2014, ch. 69 part); Young et al. (2016, ds 2, ch. 80); Ristevski et al. (2018, ds 2, ch. 108); Smith et al. (in review, ds 1, ch. 110); Ősi et al. (2018, ds 1, ch. 123); Foffa et al. (2019, ch. 128).* *State (1) is a putative apomorphy of Crocodyliformes (reversals in Thalattosuchia and* Iharkutosuchus makadii*), but also occurs in some 'sphenosuchians'.* 0. absent 1. present
140	**Squamosal dorsolateral edge, longitudinal groove margins: (*)** *Young & Andrade (2009, ch. 112 part); Young et al. (2011, ch. 112 part); Young et al. (2013a, ch. 58 part); Young et al. (2012, ch. 67 part); Young (2014, ch. 69 part); Young et al. (2016, ds 2, ch. 81); Ristevski et al. (2018, ds 2, ch. 109); Smith et al. (in review, ds 1, ch. 111); Ősi et al. (2018, ds 1, ch. 124); Foffa et al. (2019, ch. 129).* *This character is not applicable for taxa that lack the squamosal longitudinal groove.* 0. ventral margin of the groove projects more laterally than the dorsal margin 1. ventral margin is directly underneath the dorsal margin
141	**Parietals, in presumed adults:** *Nesbitt (2011, ch. 58); Young et al. (2016, ds 2, ch. 82); Ristevski et al. (2018, ds 2, ch. 110); Smith et al. (in review, ds 1, ch. 111); Ősi et al. (2018, ds 1, ch. 125); Foffa et al. (2019, ch. 130).* 0. separate 1. interparietal suture partially or completely absent (i.e. surface fusion)
142	**Parietals, supratemporal (= dorsotemporal) fenestrae separated by: (*)** *Clark et al. (2000, ch. 17 mod.); Clark & Sues (2002, ch. 18 mod.); Sues et al. (2003, ch. 18 mod.); Clark et al. (2004, ch. 18 mod.); Nesbitt (2011, ch. 59 mod.); Pol et al. (2013, ch. 18 mod.); Young et al. (2016, ds 2, ch. 83 mod.); Leardi et al. (2017, ch. 18 mod.); Ristevski et al. (2018, ds 2, ch. 111); Smith et al. (in review, ds 1, ch. 113); Ősi et al. (2018, ds 1, ch. 126); Foffa et al. (2019, ch. 131).* *Ősi et al. (2018) added state (3).* *State (3) occurs in* Dromicosuchus *and* Hesperosuchus *cf*. agilis*.* *This character is not applicable for taxa that lack the supratemporal fenestrae.* 0. broad, flat area 1. supratemporal fossa separated by a mediolaterally thin strip of flat bone 2. supratemporal fossa separated by a ''sagittal crest'' (which may be divided by the interparietal suture) 3. supratemporal fossa separated by a median longitudinal groove between paired parietal crests
143	**Intertemporal bar (= frontoparietal), modification of the "sagittal crest": (*)** *Ristevski et al. (2018, ds 2, ch. 112); Smith et al. (in review, ds 1, ch. 114); Ősi et al. (2018, ds 1, ch. 127); Foffa et al. (2019, ch. 132).* *Character following Jouve et al. (2005a: figure 8), Hastings et al. (2010, ch. 9).* *Note this character scores the distinct thin intertemporal bar of derived dyrosaurids. In Thalattosuchia the bar is not consistently thin along its entire length (being noticeably broad anteriorly).* *This character is not applicable for taxa that lack the supratemporal fenestrae.* 0. either not a "sagittal crest", or does not have the derived dyrosaurid morphotype 1. has the derived dyrosaurid morphotype: the intertemporal bar is composed of the frontal posterior process anteriorly and the parietal anterior process in the middle-and-posterior region, with a consistently thin bar along its entire length, and lateral margins deeply excavated creating a broad lateral supratemporal fossa

144	**Parietal, bifurcation of the parietal in dorsal view, immediately posterior to the intertemporal bar:** *Young et al. (2016, ds 2, ch. 84); Ristevski et al. (2018, ds 2, ch. 113); Smith et al. (in review, ds 1, ch. 115); Ősi et al. (2018, ds 1, ch. 128); Foffa et al. (2019, ch. 133).* *State (1) is found in* 'Dakosaurus' lissocephalus, Cricosaurus araucanensis, C. elegans, C. lithographicus, C. schroederi *and* C. vignaudi. *This character replaces the character that described the posterior margin of the parietal-squamosal in dorsal view – Wilkinson et al. (2008, ch. 42); Young & Andrade (2009, ch. 42); Young et al. (2011, ch. 42); Young et al. (2013a, ch. 59); Young et al. (2012, ch. 68); Young (2014, ch. 70).* 0. absent 1. present
145	**Parietals, posterodorsal margin:** *Jouve (2005, ch. 7 mod.), Jouve et al. (2005b, ch. 11 mod.), Jouve et al. (2008, ch. 11 mod.), Hastings et al. (2010, ch. 42 mod.); Ristevski et al. (2018, ds 2, ch. 114); Smith et al. (in review, ds 1, ch. 116); Ősi et al. (2018, ds 1, ch. 129); Foffa et al. (2019, ch. 134).* *State (1) occurs in derived dyrosaurids.* 0. transversely oriented 1. indented anteriorly
146	**Parietals, posteroventral edge:** *Nesbitt (2011, ch. 60); Young et al. (2016, ds 2, ch. 85); Ristevski et al. (2018, ds 2, ch. 115); Smith et al. (in review, ds 1, ch. 117); Ősi et al. (2018, ds 1, ch. 130); Foffa et al. (2019, ch. 135).* *State (1) is a putative apomorphy of Crocodyliformes.* 0. extending more than half the width of the occiput 1. extending less than half the width of the occiput
147	**Post-temporal fenestrae obscured in dorsal view by an overhanging posterior extension of the parietal:** *Jouve et al. (2008, ch. 34 mod.); Hastings et al. (2010, ch. 46 mod.); Ristevski et al. (2018, ds 2, ch. 116); Smith et al. (in review, ds 1, ch. 118); Ősi et al. (2018, ds 1, ch. 131); Foffa et al. (2019, ch. 136).* *State (1) occurs in derived dyrosaurids.* 0. absent 1. present
148	**Parietal in occipital view:** *Jouve et al. (2008, ch. 32 mod.); Hastings et al. (2010, ch. 44 mod.); Ristevski et al. (2018, ds 2, ch. 117); Smith et al. (in review, ds 1, ch. 119); Ősi et al. (2018, ds 1, ch. 132); Foffa et al. (2019, ch. 137).* 0. 'W-shaped' 1. concave 2. flat or convex

Orbit and temporal region (Ch. 149 – 178; 6.109% of characters)

[orbit, circumorbital contributions, ossa palpebralia, ossa scleroticalia, dermatocranial bones (= ossa jugalia, ossa postfrontalia, postorbital bars and ossa quadratojugalia), infratemporal fenestrae]

#	Description
149	**Orbit, position:** *Young (2006, ch. 3 mod.); Wilkinson et al. (2008, ch. 18 mod.); Young & Andrade (2009, ch. 18 mod.); Andrade et al. (2011, ch. 157 mod.); Young et al. (2011, ch. 18); Young et al. (2013a, ch. 60); Young et al. (2012, ch. 69); Young (2014, ch. 71); Young et al. (2016, ds 2, ch. 86); Ristevski et al. (2018, ds 2, ch. 118); Smith et al.*

	(in review, ds 1, ch. 120); Ősi et al. (2018, ds 1, ch. 133); Foffa et al. (2019, ch. 138). *Note that the teleosauroid* Plagiophthalmosuchus gracilirostris *scores as state (2).* *Note, when scoring the orientation of the orbits, the palpebrals must not be considered.* 0. fully dorsal 1. mainly dorsal, but with slight inclination 2. lateral, but slightly inclined dorsally, usually visible in dorsal view 3. fully lateral with orbit shape only clear in lateral view
150	**Orbit, shape:** *Young & Andrade (2009, ch. 96); Young et al. (2011, ch. 96); Young et al. (2013a, ch. 61); Young et al. (2012, ch. 70); Young (2014, ch. 72); Young et al. (2016, ds 2, ch. 87); Ristevski et al. (2018, ds 2, ch. 119); Smith et al. (in review, ds 1, ch. 121); Ősi et al. (2018, ds 1, ch. 134); Foffa et al. (2019, ch. 139).* 0. circular, anteroposterior and dorsoventral axes subequal (± 5%) 1. longitudinal ellipsoid, anteroposterior axis more than 10% longer than mediolateral axis 2. transverse ellipsoid, mediolateral axis more than 10% longer than anteroposterior axis
151	**Circumorbital dorsal margin, shape:** *Brochu (1999, ch. 103 mod.); Salas-Gismondi et al. (2016, ch. 137 mod.); Smith et al. (in review, ds 1, ch. 122); Ősi et al. (2018, ds 1, ch. 135); Foffa et al. (2019, ch. 140).* *For an explanation of this character see Figure 7 in Salas-Gismondi et al. (2016).* *State (1) occurs in the French* Pholidosaurus specimen*,* Elosuchus*,* Indosinosuchus potamosiamensis*,* Aeolodon priscus*,* Teleosaurus cadomensis*, and* Mycterosuchus nasutus*.* *State (2) occurs in* Vectisuchus*,* Sarcosuchus*,* Gavialis gangeticus*.* Chalawan thailandicus *has evidence of the dorsal medial margin being upturned, but the posterior margins of the orbits are not preserved (Martin et al., 2014)*. *Note this character is not equivalent to having a concave frontal, as here it is the upturning of the orbital margins that are being scored. Among many taxa with 'telescoped' orbits the frontal is also concave, but not all tethysuchians with concave frontals have the 'telescoped' orbit condition.* *This character helps to quantify the 'telescoped' orbit morphology.* 0. dorsal margins of orbits are flush with the skull dorsal surface 1. dorsal margins of orbits upturned (prominent along the orbital medial margin in dorsal view, with the frontal interorbital margins being upturned) 2. dorsal and posterior margins are upturned (the frontal lateral process anterior margins are also upturned)
152	**Circumorbital ventral margin, shape:** *Salas-Gismondi et al. (2016, ch. 138 mod.); Smith et al. (in review, ds 1, ch. 123); Ősi et al. (i2018, ds 1, ch. 136); Foffa et al. (2019, ch. 141).* *State (1) occurs in* Vectisuchus*,* Sarcosuchus*,* Gavialis gangeticus*.* Chalawan thailandicus *has evidence of the dorsal medial margin being upturned, but the anterior margins of the orbits are not preserved (Martin et al., 2014)*. *State (1) is caused by the 'upturning' of the preorbital bones (in particular the lachrymals), changing the shape of the anterior orbit margin. As shown by Salas-Gismondi et al. (2016) the accumulation of characters relating to orbital 'telescoping' is gradual, thus not all taxa will score for all character states relating to this morphofunctional complex.* *This character helps to quantify the 'telescoped' orbit morphology.* 0. ventral margin of the orbit is either concave or sub-straight 1. ventral margin of the orbit has a prominent notch
153	**Orbit, anterodorsal margin and the lachrymal:** *Young & Andrade (2009, ch. 124 part); Young et al. (2011, ch. 124 part); Young et al. (2013a, ch. 62 part); Young et al. (2012, ch. 71); Young (2014, ch. 73); Young et*

	al. (2016, ds 2, ch. 88); Ristevski et al. (2018, ds 2, ch. 120); Smith et al. (in review, ds 1, ch. 124); Ősi et al. (2018, ds 1, ch. 137); Foffa et al. (2019, ch. 142). *In Thalattosuchia, state (1) is a putative autapomorphy of* Teleidosaurus calvadosii 0. lachrymal is excluded from the orbit anterodorsal margin 1. lachrymal reaches the orbit anterodorsal margin
154	**Orbit, posterodorsal margin and the postorbital:** *Young & Andrade (2009, ch. 124 part); Young et al. (2011, ch. 124 part); Young et al. (2013a, ch. 62 part); Young et al. (2012, ch. 72); Young (2014, ch. 74); Young et al. (2016, ds 2, ch. 89); Ristevski et al. (2018, ds 2, ch. 121); Smith et al. (in review, ds 1, ch. 125); Ősi et al. (2018, ds 1, ch. 138); Foffa et al. (2019, ch. 143).* *In Thalattosuchia, state (1) is a putative apomorphy of the clade* Teleidosaurus + *Metriorhynchidae* 0. postorbital is excluded from the orbit posterodorsal margin 1. postorbital reaches the orbit posterodorsal margin
155	**Orbit, anteroventral margin and the lachrymal:** *Young & Andrade (2009, ch. 95 part); Young et al. (2011, ch. 95 part); Young et al. (2013a, ch. 63 part); Young et al. (2012, ch. 73); Young (2014, ch. 75); Young et al. (2016, ds 2, ch. 90); Ristevski et al. (2018, ds 2, ch. 122); Smith et al. (in review, ds 1, ch. 126); Ősi et al. (2018, ds 1, ch. 139); Foffa et al. (2019, ch. 144).* 0. lachrymal is excluded from the orbit anteroventral margin 1. lachrymal reaches the orbit anteroventral margin
156	**Orbit, anterior margin and the jugal anterior process:** *Ristevski et al. (2018, ds 2, ch. 123); Smith et al. (in review, ds 1, ch. 127); Ősi et al. (2018, ds 1, ch. 140); Foffa et al. (2019, ch. 145).* *State (1) is a putative apomorphy of* Goniopholis *and* Anteophthalmosuchus. 0. the jugal anterior process does not contribute to the anterior margin of the orbit 1. the jugal anterior process, along with the lachrymal, forms the anterior margin of the orbit. Note that the broad anterior expansion of the jugal anterior process only occurs in *Goniopholis*, as *Anteophthalmosuchus* has a narrow jugal anterior process.
157	**Orbit, anterior margin and the broadening of the jugal anterior process:** *Ristevski et al. (2018, ds 2, ch. 124); Smith et al. (in review, ds 1, ch. 128); Ősi et al. (2018, ds 1, ch. 141); Foffa et al. (2019, ch. 146).* *State (1) is a putative apomorphy of* Goniopholis 0. the jugal anterior process does not help form the anterior margin of the orbit, or as in *Anteophthalmosuchus*, it does help for the anterior margin of the orbit – but the jugal anterior process is still narrow 1. the jugal anterior process, along with the lachrymal, forms the anterior margin of the orbit, but it is distinctly broad dorsoventrally – expanded having a broad contact with the lachrymal dorsally and the maxilla anteriorly, much more so than in other derived goniopholidids.
158	**Orbit, posteroventral margin and the postorbital:** *Young & Andrade (2009, ch. 95 part); Young et al. (2011, ch. 95 part); Young et al. (2013a, ch. 63 part); Young et al. (2012, ch. 74); Young (2014, ch. 76); Young et al. (2016, ds 2, ch. 91); Ristevski et al. (2018, ds 2, ch. 125); Smith et al. (in review, ds 1, ch. 129); Ősi et al. (2018, ds 1, ch. 142); Foffa et al. (2019, ch. 147).* *In Thalattosuchia, state (1) occurs in basal teleosauroids (*Mystriosaurus laurillardi, *the Chinese teleosauroid*, Indosinosuchus potamosiamensis*,* Platysuchus multiscrobiculatus*,* Mycterosuchus nasutus *and* Teleosaurus cadomensis). *Note that some dorsoventral crushed skulls also look as though they have state (1), e.g.* Macrospondylus bollensis. 0. postorbital is excluded from the orbit posteroventral margin, or only present in the posteroventral margin 1. postorbital reaches the orbit posteroventral margin (with the postorbital overlapping the jugal), and extensively forms part of the orbit ventral margin (in some instances excluding the jugal)
159	**Orbit, ventral margin and the jugal:**

	Mueller-Töwe (2006, ch. 139 mod.); Young & Andrade (2009, ch. 95 part); Andrade et al. (2011, ch. 171 mod.); Young et al. (2011, ch. 95 part); Young et al. (2013a, ch. 63 part); Young et al. (2012, ch. 75); Young (2014, ch. 77); Young et al. (2016, ds 2, ch. 92); Ristevski et al. (2018, ds 2, ch. 126); Smith et al. (in review, ds 1, ch. 130); Ősi et al. (2018, ds 1, ch. 143); Foffa et al. (2019, ch. 148). *In Thalattosuchia, state (1) is a putative autapomorphy of* Platysuchus multiscrobiculatus 0. jugal participates in the orbit ventral margin 1. jugal excluded from the orbit by lachrymal-postorbital contact
160	**Supraorbital notch in dorsal view, deeply excavated creating an approximately semi-circular shape, resulting in the frontal being broadly exposed along the lateral margin of the orbits: (*)** *Young et al. (2016, ds 2, ch. 93); Ristevski et al. (2018, ds 2, ch. 127); Smith et al. (in review, ds 1, ch. 131); Ősi et al. (2018, ds 1, ch. 144); Foffa et al. (2019, ch. 149).* *State (1) is a putative apomorphy of a subclade within Rhacheosaurini.* *This character is not applicable for non-metriorhynchids, due to the unique formation of the supraorbital notch in Metriorhynchidae.* 0. absent 1. present
161	**Supraorbital notch in dorsal view, very small, being a tight "U"-shape, created by the prefrontal being expanded posteriorly. This results in the prefrontal making a larger contribution to the orbit dorsal margin and the frontal contribution to the orbit dorsal margin is greatly reduced, and in some taxa being excluded from the centre of the orbital dorsal margin: (*)** *Young et al. (2016, ds 2, ch. 94); Ristevski et al. (2018, ds 2, ch. 128); Smith et al. (in review, ds 1, ch. 132); Ősi et al. (2018, ds 1, ch. 145); Foffa et al. (2019, ch. 150).* *State (1) is occurs in* Metriorhynchus palpebrosus*,* Cricosaurus saltillensis *and* C. macrospondylus. *This character is not applicable for non-metriorhynchids, due to the unique formation of the supraorbital notch in Metriorhynchidae.* 0. absent 1. present
162	**Palpebrals, presence and number:** *Clark (1994, ch. 65 mod.); Young (2006, ch. 52 mod.); Turner & Buckley (2008, ch. 65); Wilkinson et al. (2008, ch. 17 mod.); Young & Andrade (2009, ch. 17 mod.); Andrade et al. (2011, ch. 186); Young et al. (2011, ch. 17 mod.); Young et al. (2013a, ch. 64 mod.); Young et al. (2012, ch. 76 mod.); Young (2014, ch. 78 mod.); Young et al. (2016, ds2, ch. 95 mod.); Ristevski et al. (2018, ds 2, ch. 129); Smith et al. (in review, ds 1, ch. 133); Ősi et al. (2018, ds 1, ch. 146); Foffa et al. (2019, ch. 151).* *Andrade et al. (2011) modified this character to exclude information about size, which can be sampled as a separate character. The presence and morphology of palpebrals is here considered to be highly devious within the analysis, always poorly sampled and including assumptions (e.g., putative fusion with prefrontals vs putative loss in thalattosuchians). Preservation and incomplete descriptions contribute to a poor use of information as a character. Scores were considered only for taxa that actually show meaningful information. The putative absence of palpebrals in thalattosuchians has long been assumed (e.g., Fraas, 1901; Andrews, 1913), but it is actually not possible to exclude that this element may be deeply fused with prefrontal, leading to this modified version of state (0).* *Can be determined by the sutural contacts along the periorbital margin.* 0. absent, or (anterior) palpebral is deeply fused with prefrontal 1. one large (anterior) palpebral present 2. two large palpebrals (anterior and posterior) present
163	**Orbits, presence of sclerotic ossicles (composing the sclerotic ring):**

	Young (2006, ch. 4); Wilkinson et al. (2008, ch. 19); Young & Andrade (2009, ch. 19); Andrade et al. (2011, ch. 159); Young et al. (2011, ch. 19); Young et al. (2013a, ch. 65); Young et al. (2012, ch. 77); Young (2014, ch. 79); Young et al. (2016, ds 2, ch. 96); Ristevski et al. (2018, ds 2, ch. 130); Smith et al. (in review, ds 1, ch. 134); Ősi et al. (2018, ds 1, ch. 147); Foffa et al. (2019, ch. 152). *Within Thalattosuchia, state (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae* *State (1) also occurs in the gobiosuchid* Cassissuchus sanziuami. 0. absent 1. present
164	**Jugal, width of anterior process relative to posterior process:** *Young & Andrade (2009, ch. 111); Young et al. (2011, ch. 111); Young et al. (2013a, ch. 66); Young et al. (2012, ch. 78); Young (2014, ch. 80); Young et al. (2016, ds 2, ch. 97); Ristevski et al. (2018, ds 2, ch. 131); Smith et al. (in review, ds 1, ch. 135); Ősi et al. (2018, ds 1, ch. 148); Foffa et al. (2019, ch. 153).* 0. subequal 1. about twice as broad
165	**Jugal, anterior process is sigmoidal with a noticeable convexity along its dorsal margin:** *Ristevski et al. (2018, ds 2, ch. 132); Smith et al. (in review, ds 1, ch. 136); Ősi et al. (2018, ds 1, ch. 149); Foffa et al. (2019, ch. 154).* *State (1) is found in* Dakosaurus + *the Vaches Noire dakosaur*. 0. absent 1. present
166	**Jugal, extends anteriorly in front of the prefrontal:** *Young & Andrade (2009, ch. 94); Young et al. (2011, ch. 94); Young et al. (2013a, ch. 67); Young et al. (2012, ch. 79); Young (2014, ch. 81); Young et al. (2016, ds 2, ch. 98); Ristevski et al. (2018, ds 2, ch. 133); Smith et al. (in review, ds 1, ch. 137); Ősi et al. (2018, ds 1, ch. 150); Foffa et al. (2019, ch. 155).* 0. no 1. yes
167	**Jugal, anterior process is slender, elongated and extends anteriorly: (NEW)** *State (1) occurs in* Neosteneosaurus edwardsi, Charitomenosuchus leedsi, Clovesuurdameredeor stephani, Proexochokefalos heberti , *and Machimosaurini.* 0. no 1. yes
168	**Postorbital bar, inclination:** *Jouve et al. (2008, ch. 35 mod.); Young & Andrade (2009, ch. 85 mod.); Hastings et al. (2010, ch. 50 mod.); Young et al. (2011, ch. 85 mod.); Young et al. (2013a, ch. 68 mod.); Young et al. (2012, ch. 80 mod.); Young (2014, ch. 82 mod.); Ristevski et al. (2018, ds 2, ch. 134); Smith et al. (in review, ds 1, ch. 138); Ősi et al. (2018, ds 1, ch. 151); Foffa et al. (2019, ch. 156).* 0. strongly anterodorsally inclined 1. slightly anterodorsally inclined 2. nearly vertical 3. posterodorsally inclined
169	**Jugal, well-developed (i.e. greatly enlarged) foramen on the anterior ramus:** *Ristevski et al. (2018, ds 2, ch. 135); Smith et al. (in review, ds 1, ch. 139); Ősi et al. (2018, ds 1, ch. 152); Foffa et al. (2019, ch. 157).* *State (1) occurs in derived dyrosaurids.* 0. no 1. yes
170	**Postfrontal:** *Nesbitt (2011, ch. 44); Young et al. (2012, ch. 81); Young (2014, ch. 83); Young et al. (2016, ds 2, ch. 100); Ristevski et al. (2018, ds 2, ch. 136); Smith et al. (in review, ds 1, ch. 140); Ősi et al. (2018, ds 1, ch. 153; Foffa et al. (2019, ch. 158).* *State (1) is a putative apomorphy of Crocodylomorpha.*

	0. present 1. absent
171	**Postorbital bar, morphology of dorsal end:** *Young & Andrade (2009, ch. 90); Young et al. (2011, ch. 90); Young et al. (2013a, ch. 69); Young et al. (2012, ch. 82); Young (2014, ch. 84); Young et al. (2016, ds 2, ch. 101); Ristevski et al. (2018, ds 2, ch. 137); Smith et al. (in review, ds 1, ch. 141); Ősi et al. (2018, ds 1, ch. 154); Foffa et al. (2019, ch. 159).* 0. dorsal end of the postorbital bar broadens dorsally, continuous with dorsal part of the postorbital 1. dorsal part of the postorbital bar constricted, distinct from the dorsal part of the postorbital
172	**Postorbital bar (postorbital), presence of a vascular opening at the lateral edge of the bar, close to the dorsal surface of the postorbital:** *Clark (1994, ch. 27); Young & Andrade (2009, ch. 114); Andrade et al. (2011, ch. 202); Young et al. (2011, ch. 114); Young et al. (2013a, ch. 70); Young et al. (2012, ch. 83); Young (2014, ch. 85); Young et al. (2016, ds 2, ch. 102); Ristevski et al. (2018, ds 2, ch. 138); Smith et al. (in review, ds 1, ch. 142); Ősi et al. (2018, ds 1, ch. 155); Foffa et al. (2019, ch. 160).* *Note that scoring of state (0) can be highly influenced by preservation.* 0. absent 1. present
173	**Postorbital bar, morphology of postorbital-jugal contact:** *Wilkinson et al. (2008, ch. 35); Young & Andrade (2009, ch. 35); Young et al. (2011, ch. 35); Young et al. (2013a, ch. 71); Young et al. (2012, ch. 84); Young (2014, ch. 86); Young et al. (2016, ds 2, ch. 103); Ristevski et al. (2018, ds 2, ch. 139); Smith et al. (in review, ds 1, ch. 143) Ősi et al. (2018, ds 1, ch. 156); Foffa et al. (2019, ch. 161).* 0. postorbital medial to jugal 1. postorbital lateral to jugal
174	**Postorbital bar, structure:** *Clark (1994, ch. 26 mod.); Wilkinson et al. (2008, ch. 36 mod.); Young & Andrade (2009, ch. 36 mod.); Young et al. (2011, ch. 36 mod.); Young et al. (2013a, ch. 72 mod.); Young et al. (2012, ch. 85 mod.); Young (2014, ch. 87 mod.); Young et al. (2016, ds 2, ch. 104 mod.); Ristevski et al. (2018, ds 2, ch. 140); Smith et al. (in review, ds 1, ch. 144); Ősi et al. (2018, ds 1, ch. 157); Foffa et al. (2019, ch. 162).* *State (1) occurs in Metasuchia.* *State (2) describes the flattened morphology of tethysuchians.* 0. dermal bar that is either not columnal or transversely flattened 1. subdermal bar that is distinctly columnar and cylindrical or oval-shaped 2. subdermal bar that is distinctly columnar and transversely flattened
175	**Postorbital bar, composition of lateral surface:** *Gasparini et al. (2006, ch. 244); Andrade et al. (2011, ch. 199); Ristevski et al. (2018, ds 2, ch. 141); Smith et al. (in review, ds 1, ch. 145); Ősi et al. (2018, ds 1, ch. 158); Foffa et al. (2019, ch. 163).* *State (1) is putative apomorphy of Thalattosuchia* 0. lateral surface formed by the postorbital and jugal 1. lateral surface formed by solely by the postorbital, with the jugal only exposed on the medial face of the bar
176	**Quadratojugal-postorbital, contact:** *Ortega et al. (2000, ch. 49); Nesbitt (2011, ch. 64); Young et al. (2016, ds 2, ch. 105); Ristevski et al. (2018, ds 2, ch. 142); Smith et al. (in review, ds 1, ch. 146); Ősi et al. (2018, ds 1, ch. 159); Foffa et al. (2019, ch. 164).* *State (1) is a putative apomorphy of Crocodyliformes (however, the presence or lack of this contact is poorly known in 'sphenosuchians', and could be a crocodylomorph apomorphy).* 0. absent 1. present

177	**Infratemporal fenestra (= laterotemporal fenestra), in lateral view:** *Young (2006, ch. 12); Wilkinson et al. (2008, ch. 32); Young & Andrade (2009, ch. 32); Young et al. (2011, ch. 32); Young et al. (2013a, ch. 73); Young et al. (2012, ch. 86); Young (2014, ch. 88); Young et al. (2016, ds 2, ch. 106); Ristevski et al. (2018, ds 2, ch. 143); Smith et al. (in review, ds 1, ch. 147); Ősi et al. (2018, ds 1, ch. 160); Foffa et al. (2019, ch. 165).* 0. considerably longer in length than the orbit (greater than 25%) 1. equal/subequal in length than the orbit (± 10%) 2. shorter in length than the orbit (less than 25%)
178	**Quadratojugal, spine (= spina quadratojugalis):** *Brochu (1999, ch. 114); Young & Andrade (2009, ch. 133); Young et al. (2011, ch. 133); Young et al. (2013a, ch. 74); Andrade et al. (2011, ch. 167 + 170). Young et al. (2012, ch. 87); Young (2014, ch. 89); Young et al. (2016, ds 2, ch. 107); Ristevski et al. (2018, ds 2, ch. 144); Smith et al. (in review, ds 1, ch. 148); Ősi et al. (2018, ds 1, ch. 161); Foffa et al. (2019, ch. 166).* 0. absent 1. either small or low crest 2. prominent

Palate and perichoanal structures (Ch. 179 – 202; 4.684% of characters) *[palate contribution of the dermatocranium facial series (= os præmaxillare and os maxillare), and dermatocranium palatal series (= ossa palatina, ossa pterygoidea, ossa ectopterygoidea and ossa vomeria)]*

#	Description
179	**Premaxillae, presence of a subelliptic naso-oral fossa (= incisive foramen, = fossa premaxillaris) at medial contact of ventral rami:** *Brochu (1999, ch. 124 part); Andrade et al. (2011, ch. 66); Young et al. (2012, ch. 89 mod.); Young (2014, ch. 91 part); Young et al. (2016, ds 2, ch. 109 mod.); Ristevski et al. (2018, ds 2, ch. 145); Smith et al. (in review, ds 1, ch. 149); Ősi et al. (2018, ds 1, ch. 162); Foffa et al. (2019, ch. 167).* *When the palate does not close completely, the passage will involve both premaxilla and maxilla, assuming a diamond-shaped profile, with edges straight to irregular, but never rounded and smooth. When the palate is incompletely closed, it is most likely that the vomer is also exposed at the opening; however, the vomer may not be preserved; or may be covered by sediment and not evident. The use of 'sub-elliptic' allows that simple openings on the palatal surface, considered as non-homologous to the naso-oral fossa, to be scored as (0).* 0. absent, premaxillae fully in contact medially along the palate 1. present as a discrete fossa or foramen, less than half the greatest width of premaxillae 2. large, more than half the greatest width of premaxillae
180	**Premaxillae, shape of naso-oral fenestra (= incisive foramen): (*)** *Young et al. (2016, ds 2, ch. 7 mod.); Ristevski et al. (2018, ds 2, ch. 146); Smith et al. (in review, ds 1, ch. 150); Ősi et al. (2018, ds 1, ch. 163); Foffa et al. (2019, ch. 168).* *In Metriorhynchidae, state (1) occurs in* Torvoneustes, *Mr Passmore's specimen* + 'M.' hastifer. *This character is not applicable for taxa that lack the naso-oral fenestra.* 0. subcircular or longer than wide (but not an elongate oval) 1. elongate anteroposterior oval-shape (can be as long or longer than the premaxillary alveoli, but not as mediolaterally broad)
181	**Suborbital fenestrae, presence and size: (ORDERED)** *Andrade et al. (2011, ch. 206); Ristevski et al. (2018, ds 1, ch. 206); Smith et al. (in review, ds 2, ch. 206); Ősi et al. (2018, ds 1, ch. 164); Foffa et al. (2019, ch. 169).* 0. absent

	1. present, much smaller than orbits 2. present, subequal or larger than orbits
182	**Suborbital fenestrae, shape of anterior border: (*)** *Andrade & Bertini (2008, ch. 86); Andrade et al. (2011, ch. 207); Ristevski et al. (2018, ds 1, ch. 207); Smith et al. (in review, ds 2, ch. 207); Ősi et al. (2018, ds 1, ch. 165); Foffa et al. (2019, ch. 170).* *The original scoring in Andrade & Bertini (2008) for* Malawisuchus *and* Candidodon *was state (1), but this could be due to taphonomic deformation, therefore both taxa should be scored as (?) until a detailed description is provided for each taxon. Nonetheless, state (1) is present in Thalattosuchia.* *This character is not applicable for taxa that lack suborbital fenestrae.* 0. rounded, smooth 1. in sharp angle, forming a notch, fissure-like
183	**Maxilla, palatal processes: (ORDERED)** *Nesbitt (2011, ch. 32); Ristevski et al. (2018, ds 2, ch. 147); Smith et al. (in review, ds 1, ch. 151); Ősi et al. (2018, ds 1, ch. 166); Foffa et al. (2019, ch. 171).* *Character helps to quantify the development of the secondary palate.* *State (2) occurs in crocodylomorphs.* 0. do not meet at the midline 1. meet at the midline 2. meet at the midline and expand anteriorly and posteriorly
184	**Maxilla, in palatal view, shape of anterior maxilla: (NEW)** *State (0) occurs in Metriorhynchoidea* *State (1) occurs in Teleosauroidea* 0. tapering (sub-triangular in shape) 1. straightened (sub-rectangular in shape)
185	**Maxilla, posterior margin of palatal processes contact with the anterior margin of palatine anterior processes:** *Young et al. (2012, ch. 90 mod.); Young (2014, ch. 92 mod.); Young et al. (2016, ds 2, ch. 110 mod.); Ristevski et al. (2018, ds 2, ch. 148); Smith et al. (in review, ds 1, ch. 152); Ősi et al. (2018, ds 1, ch. 167); Foffa et al. (2019, ch. 172).* *Character helps to quantify the development of the secondary palate.* *State (1) occurs in the clade Shartegosuchidae + Mesoeucrocodylia.* *Note, for* Calsoyasuchus *we interpret the 'primary choanae' as maxillo-palatine fenestrae.* 0. the maxilla-palatine contact only along a margin medial to the alveolar row 1. the maxilla posterior palatal margin has an extensive contact with the palatine anterior palatal margin. This results in either the vomer being excluded from the palatal surface, or if maxillo-palatine fenestrae are present, the vomer is visible within. The maxillo-palatine contact forms a continuous surface as the two elements contact one another, or when maxillo-palatine fenestrae are present, the anterior-most region of the contact is interrupted.

186	**Palate canals, presence: (*)** *Andrade et al. (2011, ch. 220); Ristevski et al. (2018, ds 2, ch. 149); Smith et al. (in review, ds 1, ch. 153); Ősi et al. (2018, ds 1, ch. 168); Foffa et al. (2019, ch. 173).* *State (1) is a putative apomorphy of Thalattosuchia.* *This character is not applicable for taxa that lack maxillary and palatine palatal processes which meet along the skull midline.* *Palate canals are a paired, parallel, elongated, tubular ducts connecting the internal nasal cavity to the oral cavity, through the palatines. The orientation is almost coincident with the horizontal plane and longitudinal axis, with very little deviation (0-5 degrees). The internal openings are located anterior to the internal end of the nasopharyngeal duct. The external openings are located at the anterior end of palatines and, because of its sub-horizontal orientation, they progress as paired shallow (but well-defined) gutter-like grooves through the palatine laminae of the maxillae, at least to mid-rostrum. In teleosauroids (the Chinese teleosauroid,* Charitomenosuchus leedsi, N. edwardsi, *specimens attributed to* Steneosaurus latifrons*) and basal metriorhynchoids (*Pelagosaurus typus *and* Eoneustes gaudryi*) these passages are located next to the medial line of the palate, very close to each other, while in Metriorhynchidae the grooves diverge anteriorly (e.g. see Andrews, 1913; Young et al. 2013). This anterior divergence is also seen in some well-preserved teleosauroids (MTY pers. obs). It is unclear if these canals constitute passages for nerves, vessels, or gland ducts.* *In specimens which have experienced dorsoventral compression, and/or are highly broken, these canals can be very hard to discern.* 0. absent 1. present
187	**Palate longitudinal depressions, presence:** *State (1) is a putative apomorphy of* Cricosaurus bambergensis*.* *Palate longitudinal depressions are paired, parallel and elongate depressions that are situated on the palatal surface of the palatines. Between the depressions, the palatines are reduced to a midline crest. Along the anterior margin of these depressions is a cluster of foramina.* *It is unclear if these canals constitute passages for nerves, vessels, or gland ducts. It is also unclear whether these depressions are related to the thalattosuchian palate canals, being a modification of the same soft-tissue morphology, or unrelated.* *This structure can be determined as palatine and not pterygoid (i.e. the internal choana) in origin, as the anterior margins are level to the end of the maxillary tooth row and the depressions themselves are ventral to the orbits. Thus, they are too anterior to be the internal choana.* 0. absent 1. present
188	**Palatine, anterior extent of the palatine relative to the maxillary tooth row:** *Young (2014, ch. 93); Young et al. (2016, ds 2, ch. 111); Ristevski et al. (2018, ds 2, ch. 150); Smith et al. (in review, ds 1, ch. 154); Ősi et al. (2018, ds 1, ch. 169); Foffa et al. (2019, ch. 174).* *State (5) is a putative autapomorphy of* Plesiosuchus manselii. 0. palatine anterior margin terminates level to 20th maxillary alveoli, or more distal alveoli 1. palatine anterior margin terminates level to 15th to 19th maxillary alveoli 2. palatine anterior margin terminates level to 11th to 14th maxillary alveoli 3. palatine anterior margin terminates level to 8th to 10th maxillary alveoli 4. palatine anterior margin terminates level to 5th to 7th maxillary alveoli 5. palatine anterior margin terminates level to 4th maxillary alveoli, or more anterior alveoli
189	**Palatine, anterior margin has a mid-line anterior process:** *Wilkinson et al. (2008, ch. 6 part); Young & Andrade (2009, ch. 6 part); Young et al. (2011, ch. 6 part); Young et al. (2013a, ch. 76 part); Young et al. (2012, ch. 91);*

	Young (2014, ch. 94); Young et al. (2016, ds 2, ch. 112); Ristevski et al. (2018, ds 2, ch. 151); Smith et al. (in review, ds 1, ch. 155); Ősi et al. (2018, ds 1, ch. 170); Foffa et al. (2019, ch. 175). 0. present 1. absent
190	**Palatine, mid-line anterior process shape, in palatal view: (*)** *Wilkinson et al. (2008, ch. 6 part); Young & Andrade (2009, ch. 6 part); Young et al. (2011, ch. 6 part); Young et al. (2013a, ch. 76 part); Young et al. (2012, ch. 92); Young (2014, ch. 95); Young et al. (2016, ds 2, ch. 113); Ristevski et al. (2018, ds 2, ch. 152); Smith et al. (in review, ds 1, ch. 156); Ősi et al. (2018, ds 1, ch. 171); Foffa et al. (2019, ch. 176).* *This character is not applicable for taxa that lack mid-line palatine palatal processes.* 0. lateral margins of the mid-line anterior process converge: anteriorly orientated "V"-shape 1. lateral margins of the mid-line anterior process largely parallel: anteriorly orientated "U"-shape
191	**Palatine, anterior margin has two non-midline anterior processes:** *Wilkinson et al. (2008, ch. 6 part); Young & Andrade (2009, ch. 6 part); Young et al. (2011, ch. 6 part); Young et al. (2013a, ch. 76 part); Young et al. (2012, ch. 93); Young (2014, ch. 96); Young et al. (2016, ds 2, ch. 114); Ristevski et al. (2018, ds 2, ch. 153); Smith et al. (in review, ds 1, ch. 157); Ősi et al. (2018, ds 1, ch. 172); Foffa et al. (2019, ch. 177).* *In Thalattosuchia, state (1) is a putative apomorphy of Metriorhynchinae.* *In* Montealtosuchus *and* Hamadasuchus *the mid-line anterior process has a concave anterior margin, creating two "non-midline" processes.* 0. absent 1. present
192	**Palatine, at the suborbital fenestrae the palatine anterior margin curves anterolaterally towards it, creating two "small processes" projecting laterally:** *Young & Andrade (2009, ch. 161); Young et al. (2011, ch. 161); Young et al. (2013a, ch. 77); Young et al. (2012, ch. 94); Young (2014, ch. 97); Young et al. (2016, ds 2, ch. 115); Ristevski et al. (2018, ds 2, ch. 154); Smith et al. (in review, ds 1, ch. 158); Ősi et al. (2018, ds 1, ch. 173); Foffa et al. (2019, ch. 178).* *This morphology is variably observed in derived neosuchians and eusuchians.* 0. absent 1. present
193	**Palate, presence of palatal shelves of palatines, and their relation with the narial passage: (ORDERED)** *Clark (1994, ch. 37 part); Wilkinson et al. (2008, ch. 8 part); Young & Andrade (2009, ch. 8 part); Andrade et al. (2011, ch. 212); Young et al. (2011, ch. 8 part); Young et al. (2013a, ch. 78 part); Young et al. (2012, ch. 95 part); Pol et al. (2013, ch. 67 part); Young (2014, ch. 98 part); Young et al. (2016, ds 2, ch. 116 part); Leardi et al. (2017, ch. 67 part); Ristevski et al. (2018, ds 1, ch. 212; ds 2, ch. 155 part); Smith et al. (in review, ds 1, ch. 159 part; ds 2, ch. 212); Ősi et al. (2018, ds 1, ch. 174); Foffa et al. (2019, ch. 179).* *Character helps to quantify the development of the secondary palate.* *State (2) occurs in Mesoeucrocodylia, and in some more basal taxa.* *Note that in state (2) the palatal laminae may not be in contact for taxa with extensive maxillopalatine fenestrae and elongate choanae (e.g.* Eutretauranosuchus*).* 0. palatal shelves of palatine absent, narial passage only bounded dorsally, by the pterygoid 1. narial passage at least partially bounded by palatal shelves of the palatine, laterally, creating the choanal grove 2. narial passage at least mostly bounded by palatal shelves of the palatine, laterally and ventrally, forming the nasopharyngeal duct

194	**Palatine, presence of a posterior extension to the choanae:** *Jouve et al. (2005b, ch. 4); Jouve et al. (2008, ch. 4); Hastings et al. (2010, ch. 61); Ristevski et al. (2018, ds 2, ch. 156); Smith et al. (in review, ds 1, ch. 160); Ősi et al. (2018, ds 1, ch. 175); Foffa et al. (2019, ch. 180).* 0. do not contact or only contact along the anterior margin 1. contact along the anterior and medial margins
195	**Palatine-pterygoid suture, lateral protrusions by palatine into the pterygoids:** *Young & Andrade (2009, ch. 132); Young et al. (2011, ch. 132); Young et al. (2013a, ch. 80); Young et al. (2012, ch. 97); Young (2014, ch. 100); Young et al. (2016, ds 2, ch. 118); Ristevski et al. (2018, ds 2, ch. 157); Smith et al. (in review, ds 1, ch. 161); Ősi et al. (2018, ds 1, ch. 176); Foffa et al. (2019, ch. 181).* 0. absent 1. present
196	**Ectopterygoid, presence of broad contact with palatine ramus of maxilla:** *Ristevski et al. (2018, ds 2, ch. 158); Smith et al. (in review, ds 1, ch. 162); Ősi et al. (2018, ds 1, ch. 177); Foffa et al. (2019, ch. 182).* *Character based on Brochu (1997, ch. 91 mod.); Andrade et al. (2011, ch. 253). Basal forms within Sphenosuchia will show no (or very limited) contact between ectopterygoid and maxilla (0). As both* Cassissuchus *and* Fruitachampsa *have a jugal-ectopterygoid contact (Clark, 2011; Buscalioni, 2017), here we find this character to be a putative apomorphy of Mesoeucrocodylia* +Hsisosuchus*, rather than Crocodyliformes as in Andrade et al. (2011). Note,* Hsisosuchus *is not in this dataset but scores as (1) in Andrade et al. (2011) dataset.* *State (1) is putative apomorphy of Mesoeucrocodylia* + Hsisosuchus *(reversals in: French* Pholidosaurus*, and* Zoneait + *Metriorhynchidae – the ectopterygoid solely contacts the jugal).* *Note that in metriorhynchids the ectopterygoid is rarely preserved, and thus hard to score. It can be scored for* Metriorhynchus superciliosus *as it has what looks like the jugal-ectopterygoid articulation in NHMUK PV R 6860. However, the ectopterygoids are complete and in articulation in both* Zoneait *and* Maledictosuchus*.* 0. absent, ectopterygoid does not contact maxilla, or barely contacts its caudal end, medial to jugal 1. present
197	**Ectopterygoid, morphology of the distal ramus: (*)** *Andrade et al. (2011, ch. 256); Ristevski et al. (2018, ds 1, ch. 256); Smith et al. (in review, ds 2, ch. 256); Ősi et al. (2018, ds 1, ch. 178); Foffa et al. (2019, ch. 183).* *Based on description by Pol & Apesteguia (2005: p. 8), where the subcylindrical profile of the distal ramus (1) was noted in* Araripesuchus buitreraensis*.* *The condition is shared at least by other* Araripesuchus*,* Montealtosuchus *and a few other basal notosuchians.* *This character is not applicable for taxa in which the ectopterygoid does not extend over the pterygoid wing.* 0. laminar, extending as a flattened sheet over the pterygoid wing 1. robust, extending as a rod over most of the pterygoid wing, with subcircular cross-section through most of its length
198	**Pterygoid flange, orientation (in palatal view):** *Young et al. (2011, ch. 186); Young et al. (2013a, ch. 81); Young et al. (2012, ch. 98); Young (2014, ch. 101); Young et al. (2016, ds 2, ch. 119); Ristevski et al. (2018, ds 2, ch. 159); Smith et al. (in review, ds 1, ch. 163); Ősi et al. (2018, ds 1, ch. 179); Foffa et al. (2019, ch. 184).* 0. horizontal 1. largely horizontal, but with a distinct posterolateral orientation 2. strongly orientated posteriorly
199	**Choanae, participation of pterygoid in the choanal border: (*)** *Clark (1994, ch. 43 mod.); Brochu (1999, ch. 71 mod.); Jouve et al. (2005, ch. 4 mod.); Turner & Buckley (2008, ch. 43 mod.); Young & Andrade (2009, ch. 131 + 139 mod.); Andrade et al. (2011, ch. 242); Young et al. (2011, ch. 131 + 139 mod.);*

	Young et al. (2013a, ch. 79 + 82 mod.); Young et al. (2012, ch. 96 + 99 mod.); Young (2014 ch. 99 + 102); Young et al. (2016, ds 2, ch. 117 + 120 mod.); Ristevski et al. (2018, ds 2, ch. 160); Smith et al. (in review, ds 1, ch. 164); Ősi et al. (2018, ds 1, ch. 180); Foffa et al. (2019, ch. 185). *Note that the palatines may be excluded from the choanal border either in states (2) and (3), but the eusuchian condition is only achieved in state (3). State (2) corresponds directly to state (1) of Jouve et al. (2005, ch. 4), apomorphic for* Elosuchus, Terminonaris, Pholidosaurus purbeckensis + *dyrosaurids.* *Note that we do not consider* Koumpiodontosuchus *or* Isisfordia *to have the eusuchian condition. Our interpretation for* Isisfordia *follows Turner & Pritchard (2015), and* Koumpiodontosuchus *has a similar morphology (MTY pers. obs.).* *This character is not applicable for taxa that lack the development of the secondary palate.* 0. pterygoid only bounds the posterior border of the choanae 1. pterygoid forms at least the posterior and lateral choanal borders 2. anterolateral rami of pterygoid embrace most of the choanae, but do not meet medially, at the anterior choanal border (either by the presence of palatine or ventral exposure and expansion of interchoanal septum) 3. anterolateral rami of pterygoid completely embrace the choanae, meeting medially at its anterior border (eusuchian choanae)
200	**Pterygoids, fusion posterior to choanae:** *Clark (1994, ch. 41); Andrade et al. (2011, ch. 258); Ristevski et al. (2018, ds 2, ch. 161); Smith et al. (in review, ds 1, ch. 165); Ősi et al. (2018, ds 1, ch. 181); Foffa et al. (2019, ch. 186).* *State (1) is putative apomorphy of* Zosuchus + *Mesoeucrocodylia.* 0. not fused 1. fused
201	**Choanal opening, in palatal view:** *Wilkinson et al. (2008, ch. 9 part); Young & Andrade (2009, ch. 9 part); Young et al. (2011, ch. 187); Young et al. (2013a, ch. 83); Young et al. (2012, ch. 100); Young (2014, ch. 103); Young et al. (2016, ch. 121); Ristevski et al. (2018, ds 2, ch. 162); Smith et al. (in review, ds 1, ch. 166); Ősi et al. (2018, ds 1, ch. 182); Foffa et al. (2019, ch. 187).* *State (1) is observed in extant species.* 0. choanal opening orientated posteriorly, enclosed ventrally by the palatine and by either the pterygoid dorsally or the maxilla 1. choana opens into palate through a deep midline depression (choanal groove)
202	**Choana, anterior margin shape:** *Wilkinson et al. (2008, ch. 9 part); Young & Andrade (2009, ch. 9 part); Young et al. (2011, ch. 9); Young et al. (2013a, ch. 84); Young et al. (2012, ch. 101); Young (2014, ch. 104); Young et al. (2016, ds 2, ch. 122); Ristevski et al. (2018, ds 2, ch. 163); Smith et al. (in review, ds 1, ch. 167); Ősi et al. (2018, ds 1, ch. 183); Foffa et al. (2019, ch. 188).* 0. semi-circular or elliptical 1. 'V'-shaped with its base directed anteriorly 2. broad 'U'-shaped with its base directed anteriorly 3. 'W'-shaped with its base directed anteriorly

Occipital (Ch. 203 – 218; 3.258% of characters)

[Partial chondrocranium = os supraoccipitale, ossa exoccipitalia + ossa opisthotica (= os otoccipitale)]

#	Description
203	**Occipital tuberosities:** *Jouve (2005, ch. 1 mod.), Jouve et al. (2005b, ch. 3 mod.), Jouve et al. (2008, ch. 3 mod.), Hastings et al. (2010, ch. 53 mod.); Young et al. (2011, ch. 188); Young et al.*

	(2013a, ch. 85); Young et al. (2012, ch. 102 mod.); Young (2014, ch. 105 mod.); Young et al. (2016, ds 2, ch. 123 mod.); Ristevski et al. (2018, ds 2, ch. 164); Smith et al. (in review, ds 1, ch. 168); Ősi et al. (2018, ds 1, ch. 184); Foffa et al. (2019, ch. 189). *State (1) occurs in teleosauroids, basal dyrosaurids and in the pholidosaurids* Sarcosuchus *and* Chalawan. *State (2) occurs in most dyrosaurids and the teleosauroid* Proexochokefalos heberti. 0. absent 1. small and reduced 2. large and well-developed
204	**Supraoccipital, presence:** *Leardi et al. (2017, ch. 97); Ősi et al. (2018, ds 1, ch. 185); Foffa et al. (2019, ch. 190).* *State (1) occurs in Crocodylomorpha.* 0. fused with the exoccipital 1. present as a separate ossification
205	**Exoccipitals, presence of medial contact between both elements:** *Clark (1994, ch. 62); Ortega et al. (2000, ch. 63); Gower (2002, ch. 19 mod.); Andrade et al. (2011, ch. 270); Nesbitt (2011, ch. 126); Young et al. (2013a, ch. 86); Young et al. (2012, ch. 103); Young (2014, ch. 106); Tennant et al. (2016, ch. 198); Young et al. (2016, ds 2, ch. 124); Ristevski et al. (2018, ds 2, ch. 166); Smith et al. (in review, ds 1, ch. 170); Ősi et al. (2018, ds 1, ch. 187); Foffa et al. (2019, ch. 191).* *Can also be defined as the participation of supraoccipital in the foramen magnum.* 0. do not meet in midline 1. meet on the midline, dorsal to the basioccipital, excluding the supraoccipital from the foramen magnum
206	**Paroccipital processes of the opisthotic, orientation in occipital view:** *Wilkinson et al. (2008, ch. 7); Young & Andrade (2009, ch. 7); Young et al. (2011, ch. 7); Young et al. (2013a, ch. 87); Young et al. (2012, ch. 104); Young (2014, ch. 107); Young et al. (2016, ds 2, ch. 125); Ristevski et al. (2018, ds 2, ch. 167); Smith et al. (in review, ds 1, ch. 171); Ősi et al. (2018, ds 1, ch. 188); Foffa et al. (2019, ch. 192).* *State (1) is a putative apomorphy of Rhacheosaurini.* *State (2) is a putative apomorphy of Geosaurinae.* *State (3) is a putative apomorphy of Dyrosauridae* + Pholidosaurus purbeckensis, *and also for* 'Dakosaurus' lissocephalus 0. horizontal 1. dorsolaterally orientated, at a 45 degree angle 2. ventral-edge horizontal, then terminal third sharply inclined dorsolaterally at a 45 degree angle 3. ventrally arched
207	**Paroccipital processes of the opisthotic, large ventrolateral region (i.e. the distal lower border is convex and bulges ventrally):** *Young & Andrade (2009, ch. 116); Young et al. (2011, ch. 116); Young et al. (2013a, ch. 88); Young et al. (2012, ch. 105); Young (2014, ch. 108); Young et al. (2016, ds 2, ch. 126); Ristevski et al. (2018, ds 2, ch. 168); Smith et al. (in review, ds 1, ch. 172); Ősi et al. (2018, ds 1, ch. 189); Foffa et al. (2019, ch. 193).* *State (1) occurs in Crocodyliformes.* 0. present 1. absent
208	**Paroccipital process, size in relation to exoccipital: (*) (NEW)** *State (1) occurs in* Machimosaurus hugii. 0. paraoccipital process and exoccipital are approximately the same size 1. paraoccipital process is substantially larger than exoccipital, greater than 25%
209	**Paroccipital process, overlap by the squamosal:**

	Young & Andrade (2009, ch. 119); Young et al. (2011, ch. 119); Young et al. (2013a, ch. 89); Young et al. (2012, ch. 106); Young (2014, ch. 109); Young et al. (2016, ds 2, ch. 127); Ristevski et al. (2018, ds 2, ch. 169); Smith et al. (in review, ds 1, ch. 173); Ősi et al. (2018, ds 1, ch. 190); Foffa et al. (2019, ch. 194). 0. small: the squamosal does not extend more posteriorly than the paroccipital process 1. large: it extends further posteriorly than the paroccipital process
210	**Foramen for cranial nerve XII (hypoglossal), position on occiput:** *Wilkinson et al. (2008, ch. 10); Young & Andrade (2009, ch. 10); Young et al. (2011, ch. 10); Young et al. (2013a, ch. 90); Young et al. (2012, ch. 107); Young (2014, ch. 110); Young et al. (2016, ds 2, ch. 129); Ristevski et al. (2018, ds 2, ch. 170); Smith et al. (in review, ds 1, ch. 174); Ősi et al. (2018, ds 1, ch. 191); Foffa et al. (2019, ch. 195).* 0. above the occipital condyle in line with the foramen magnum 1. below the foramen magnum
211	**Foramen for cranial nerve XII (hypoglossal), sits in the dorsomedial corner of 'occipital fossae' – concave depressions on the exoccipital on either side of the skull midline:** *Ristevski et al. (2018, ds 2, ch. 171); Smith et al. (in review, ds 1, ch. 175); Ősi et al. (2018, ds 1, ch. 192); Foffa et al. (2019, ch. 196).* *State (1) occurs in* Torvoneustes. 0. absent 1. present
212	**Foramen for the internal carotid artery, external margin of the foramen is raised relative to the posterior face of the basioccipital, forming a sub-rectangular shape:** *Ristevski et al. (2018, ds 2, ch. 172); Smith et al. (in review, ds 1, ch. 176); Ősi et al. (2018, ds 1, ch. 193); Foffa et al. (2019, ch. 197).* *State (1) occurs in* Torvoneustes. 0. no 1. yes
213	**Foramen for the internal carotid artery, size:** *Wilkinson et al. (2008, ch. 11); Young & Andrade (2009, ch. 11); Young et al. (2011, ch. 11); Young et al. (2013a, ch. 91); Young et al. (2012, ch. 108); Young (2014, ch. 111); Young et al. (2016, ds 2, ch. 130); Ristevski et al. (2018, ds 2, ch. 173); Smith et al. (in review, ds 1, ch. 177); Ősi et al. (2018, ds 1, ch. 194); Foffa et al. (2019, ch. 198).* *State (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* 0. similar in size to the openings for cranial nerves IX–XI 1. extremely enlarged
214	**Exoccipital, presence of descending flange ventral to subcapsular process:** *Clark (1994, ch. 58); Andrade et al. (2011, ch. 273); Ristevski et al. (2018, ds 2, ch. 174); Smith et al. (in review, ds 1, ch. 178); Ősi et al. (2018, ds 1, ch. 195); Foffa et al. (2019, ch. 199).* *State (1) is putative apomorphy of protosuchids, but also present at least in* Araripesuchus tsangatsangana. 0. absent 1. present, laterally concave
215	**Exoccipital, extent of contact with the quadrate:** *Clark (1994, ch. 48 mod. + 51); Andrade et al. (2011, ch. 274); Ristevski et al. (2018, ds 2, ch. 175); Smith et al. (in review, ds 1, ch. 179); Ősi et al. (2018, ds 1, ch. 196); Foffa et al. (2019, ch. 200).* *Andrade et al. (2011) merged characters 48 and 51 of Clark (1994), into one ordered series, as both refer to the contact between exoccipitals and quadrate. Following the present format, state (1) is a putative apomorphy of Gobiosuchidae + Mesoeucrocodylia.* 0. absent or narrow

	1. broad contact present, stabilising the quadrate
216	**Exoccipital, presence of ventrolateral contact with the ventromedial part of quadrate:** *Clark (1994, ch. 51 mod.); Andrade et al. (2011, ch. 275); Ristevski et al. (2018, ds 1, ch. 275); Smith et al. (in review, ds 2, ch. 275); Ősi et al. (2018, ds 1, ch. 197); Foffa et al. (2019, ch. 201).* *Focus of character (51) modified from quadrate to exoccipital, to make evident its relation with character 48 (original numbers of Clark, 1994). Note that both characters may be fused into one ordered series, as they refer to the contact between both elements.* *Following the present format, (1) is putative apomorphy of* Junggarsuchus + *Crocodyliformes.* 0. absent, quadrate does not contact exoccipital 1. present, exoccipital and quadrate enclosing carotid artery and forming passage for cranial nerves IX-XI
217	**Exoccipital, participation in the occipital condyle:** *Jouve (2004, ch. 96 mod.); Jouve et al. (2005b, ch. 5 mod.); Jouve et al. (2006, ch. 104 mod.); Jouve et al. (2008, ch. 5 mod.); Hastings et al. (2010, ch. 52 mod.); Ristevski et al. (2018, ds 2, ch. 176); Smith et al. (in review, ds 1, ch. 180); Ősi et al. (2018, ds 1, ch. 198); Foffa et al. (2019, ch. 202).* *This scores the large contribution of the otocciptials to the occipital condyle seen in dyrosaurids, where the otoccipitals broadly contact the lateral margins of the condyle.* 0. slight to moderate 1. large, such that only a thin strip of the basioccipital is visible between the exoccipitals on the dorsal surface of the occipital condyle
218	**Occipital surface ventral to occipital condyle:** *Young & Andrade (2009, ch. 143); Young et al. (2011, ch. 143); Young et al. (2013a, ch. 92); Young et al. (2012, ch. 109); Young (2014, ch. 112); Young et al. (2016, ds 2, ch. 131); Ristevski et al. (2018, ds 2, ch. 177); Smith et al. (in review, ds 1, ch. 181); Ősi et al. (2018, ds 1, ch. 199); Foffa et al. (2019, ch. 203).* *State (1) is a putative apomorphy of Crocodylia.* 0. slopes anteroventrally 1. sub-parallel or parallel to the transverse plane

Braincase, basicranium and suspensorium (Ch. 219 – 244; 5.295% of characters)

[Partial chondrocranium (= ossa laterosphenoidea, ossa prootica, os basioccipitale, os basisphenoideum); partial splanchnocranium (= ossa quadrata); pneumatic foramina; cranioquadrate canal]

#	Description
219	**Trigeminal fossa (= fossa for cranial nerve V), development on quadrate and laterosphenoid:** *Young et al. (2013a, ch. 93); Young et al. (2012, ch. 110); Young (2014, ch. 113); Young et al. (2016, ds 2, ch. 132); Ristevski et al. (2018, ds 2, ch. 178); Smith et al. (in review, ds 1, ch. 182); Ősi et al. (2018, ds 1, ch. 200); Foffa et al. (2019, ch. 204).* *Character based on the discovery by Fernández et al. (2011).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. developed anteriorly and posteriorly to the trigeminal fenestra (i.e. fossa present on both laterosphenoid and quadrate) 1. fossa is mainly developed posteriorly to the fenestra (i.e. fossa present on quadrate)
220	**Laterosphenoids, sutures with parietal:**

	Hastings et al. (2010, ch. 63 mod.); Ristevski et al. (2018, ds 2, ch. 179); Smith et al. (in review, ds 1, ch. 183); Ősi et al. (2018, ds 1, ch. 201); Foffa et al. (2019, ch. 205). 0. parallel to the skull table 1. descends posteriorly, relative to the skull table
221	**Laterosphenoids, fossae for the *m. pseudotemporalis superficialis*:** *Young et al. (2013a, ch. 94 mod.); Young et al. (2012, ch. 111 mod.); Young (2014, ch. 114 mod.); Young et al. (2016, ds 2, ch. 133 mod.); Ristevski et al. (2018, ds 2, ch. 180); Smith et al. (in review, ds 1, ch. 184); Ősi et al. (2018, ds 1, ch. 202); Foffa et al. (2019, ch. 206).* *Character based upon data from Holliday & Witmer (2009) and Fernández et al. (2011).* *State (1) is a putative apomorphy of Metasuchia.* 0. presence of a *pseudotemporalis* fossa on the dorsal surface of the laterosphenoid, and/or continuing on to the frontal 1. either an absence of the pseudotemporalis fossa on the dorsal surface of the laterosphenoid (i.e. only the *m. adductor mandibulae externus profundus* is within the supratemporal fenestra), or scorable by the presence of the fossa on the posteroventral surface of the laterosphenoid (the “subfenestral position”)
222	**Parasphenoid ridge/rostrum (?), in palatal view:** *Wilkinson et al. (2008, ch. 4); Young & Andrade (2009, ch. 4); Young et al. (2011, ch. 4); Young et al. (2013a, ch. 95); Young et al. (2012, ch. 112); Young (2014, ch. 115); Young et al. (2016, ds 2, ch. 134); Ristevski et al. (2018, ds 2, ch. 181); Smith et al. (in review, ds 1, ch. 185); Ősi et al. (2018, ds 1, ch. 203); Foffa et al. (2019, ch. 207).* *The homology of this ridge is unknown. Andrews (1913) considered the midline pterygoid ridge to be the parasphenoid. However, the pterygoids are poorly known for metriorhynchids, and we cannot discount this as a purely pterygoid structure. Until this structure has undergone CT scanning we will provisionally use the term parasphenoid.* 0. not visible 1. forms a midline ridge along the pterygoids
223	**Basisphenoid, paired ridges located medially on the ventral surface:** *Young & Andrade (2009, ch. 83); Young et al. (2011, ch. 83); Young et al. (2013a, ch. 96); Young et al. (2012, ch. 113); Young (2014, ch. 116); Young et al. (2016, ds 2, ch. 135); Ristevski et al. (2018, ds 2, ch. 182); Smith et al. (in review, ds 1, ch. 186); Ősi et al. (2018, ds 1, ch. 204; . Foffa et al. (2019, ch. 208).* *State (1) occurs in Teleosauroidea.* 0. absent 1. present
224	**Basisphenoid, ventral exposure in adults and young individuals, but not immature or hatchlings: (ORDERED)** *Clark (1994, ch. 55 rev. + 56 rev.); Ortega et al. (2000, ch. 68 mod.); Young & Andrade (2009, ch. 87 mod.); Andrade et al. (2011, ch. 286 mod.); Young et al. (2011, ch. 87 mod.); Young et al. (2013a, ch. 97 mod.); Young et al. (2012, ch. 114 mod.); Young (2014, ch. 117 mod.); Young et al. (2016, ds 2, ch. 136 mod.); Ristevski et al. (2018, ds 2, ch. 183); Smith et al. (in review, ds 1, ch. 187); Ősi et al. (2018, ds 1, ch. 205); Foffa et al. (2019, ch. 209).* *Original characters by Clark (1994, ch. 55-56) actually reflect the size of basisphenoid and here were combined into one character by Andrade et al. (2011). Note disagreement in the scorings from previous works, e.g., Clark (1994) considered thalattosuchians as (0) and Turner & Buckley (2008) considers them as (1); Turner & Buckley (2008) considers* Mahajangasuchus *as (2), whereas here it is considered as (1). Most authors consider "Sphenosuchians" as (1), but the basisphenoid is well exposed at least in* Gracilisuchus*,* Sphenosuchus *and possibly in* Pseudhesperosuchus *(see Bonaparte, 1971; Romer, 1972; Walker, 1990). Further scorings by Turner & Buckley (2008).*

	Note Ristevski et al. (2018, ds 2) re-ordered the character from Andrade et al. (2011). State (2) is now (0), and state (0) is now (2). State (1) is unaffected. 0. ample surface exposed ventrally, basisphenoid at least as long as the basioccipital, or longer 1. well-exposed, although basisphenoid surface clearly smaller than basioccipital surface 2. extremely reduced surface, exposed as a transversal slit, almost obliterated ventrally by the basioccipital and the pterygoids
225	**Basisphenoid, exposure anterior to the quadrates in palatal view:** *Wilkinson et al. (2008, ch. 5 mod.); Young & Andrade (2009, ch. 5 mod.); Young et al. (2011, ch. 5 mod.); Young et al. (2013a, ch. 98); Young et al. (2012, ch. 115); Young (2014, ch. 118); Young et al. (2016, ds 2, ch. 137); Ristevski et al. (2018, ds 2, ch. 184); Smith et al. (in review, ds 1, ch. 188); Ősi et al. (2018, ds 1, ch. 206); Foffa et al. (2019, ch. 210).* *State (1) is a putative apomorphy of a teleosauroid subclade. This character state is caused by the posterior expansion of the pterygoid's posterior margin, so that the anterior portion of the quadrates is obscured, as are the lateral margins of the basisphenoid. However, there is a distinct basisphenoid 'rostrum' that in some taxa continue to bifurcate the pterygoids anteriorly. This morphology is not observed in* Teleosaurus cadomensis*, the Chinese teleosauorid*, Pelagosaurus typus *or Metriorhynchidae.* 0. absent, or basisphenoid terminates approximately level to the anterior extent of the quadrates 1. basisphenoid 'rostrum'/cultriform process exposed along the palatal surface anterior to the quadrates, continuing to bifurcate the pterygoids
226	**Basisphenoid rostrum (= cultriform process):** *Jouve (2005, ch. 2), Jouve et al. (2005b, ch. 7), Jouve et al. (2008, ch. 7), Hastings et al. (2010, ch. 54); Ristevski et al. (2018, ds 2, ch. 185); Smith et al. (in review, ds 1, ch. 189); Ősi et al. (2018, ds 1, ch. 207); Foffa et al. (2019, ch. 211).* *State (1) is observed in some derived dyrosaurids. This character is not homologous with the anterior projection of the basisphenoid observed in teleosauroids. Here, the basisphenoid projects anteriorly between the pterygoids and laterosphenoids, rather than bifurcating the former.* 0. short 1. extremely long anteriorly
227	**Basisphenoid, exposure ventral to the basioccipital at maturity in occipital aspect:** *Young & Andrade (2009, ch. 144); Young et al. (2011, ch. 144); Young et al. (2013a, ch. 99); Young et al. (2012, ch. 116); Young (2014, ch. 119); Young et al. (2016, ds 2, ch. 138); Ristevski et al. (2018, ds 2, ch. 186); Smith et al. (in review, ds 1, ch. 190); Ősi et al. (2018, ds 1, ch. 208); Foffa et al. (2019, ch. 212).* *State (1) is a putative apomorphy of Eusuchia.* 0. absent, pterygoid dorsoventrally short ventral to median pharyngeal opening (= "medial Eustachian foramen") 1. present, pterygoid dorsoventrally tall ventral to median pharyngeal opening
228	**Basisphenoid, development of basipterygoid processes:** *Clark (1994, ch. 54 rev.); Andrade et al. (2011, ch. 289 mod.); Ristevski et al. (2018, ds 2, ch. 187); Smith et al. (in review, ds 1, ch. 191); Ősi et al. (2018, ds 1, ch. 209); Foffa et al. (2019, ch. 213).* *State (1) occurs in Crocodyliformes.* 0. prominent, forming a movable joint with pterygoid, and with basisphenoid joint suturally closed 1. small or absent
229	**Basioccipital, single wide rugosity oriented anteroposteriorly along the midline of the ventral surface of the occipital condyle:**

	Hastings et al. (2010, ch. 55 mod.); Ristevski et al. (2018, ds 2, ch. 188); Smith et al. (in review, ds 1, ch. 192); Ősi et al. (2018, ds 1, ch. 210); Foffa et al. (2019, ch. 214). 0. absent 1. present
230	**Basioccipital, presence of tuberosities (= basal tubera):** *Clark (1994, ch. 57); Lauprasert et al. (2007, ch. 46); Young & Andrade (2009, ch. 151); Andrade et al. (2011, ch. 288); Young et al. (2011, ch. 151); Young et al. (2013a, ch. 100); Young et al. (2012, ch. 117); Young (2014, ch. 120); Young et al. (2016, ds 2, ch. 139); Ristevski et al. (2018, ds 2, ch. 189); Smith et al. (in review, ds 1, ch. 193); Ősi et al. (2018, ds 1, ch. 211); Foffa et al. (2019, ch. 215).* *State (1) occurs in longirostrine taxa.* 0. reduced 1. large and pendulous
231	**Basioccipital tuberosities, in ventral view:** *Hastings et al. (2010, ch. 56 mod.); Ristevski et al. (2018, ds 2, ch. 190); Smith et al. (in review, ds 1, ch. 194); Ősi et al. (2018, ds 1, ch. 212); Foffa et al. (2019, ch. 216).* 0. oblong-shaped 1. 'V'-shaped or tear-drop shaped
232	**Paired grooves along ventral surface, extending from base of the occipital condyle to the basioccipital tuberosities:** *Hastings et al. (2010, ch. 57 mod.); Ristevski et al. (2018, ds 2, ch. 191); Smith et al. (in review, ds 1, ch. 195); Ősi et al. (2018, ds 1, ch. 213); Foffa et al. (2019, ch. 217).* 0. absent 1. present
233	**Ventral part of the basioccipital:** *Jouve et al. (2005b, ch. 13), Jouve et al. (2008, ch. 13), Hastings et al. (2010, ch. 59); Ristevski et al. (2018, ds 2, ch. 192); Smith et al. (in review, ds 1, ch. 196); Ősi et al. (2018, ds 1, ch. 214); Foffa et al. (2019, ch. 218).* 0. vertical, largely visible in occipital view 1. strongly inclined, weakly visible in occipital view
234	**Quadrate, prominent crest on dorsal surface of distal quadrate extending proximally to lateral extent of quadrate–exoccipital contact:** *Young & Andrade (2009, ch. 101); Young et al. (2011, ch. 101); Young et al. (2013a, ch. 101); Young et al. (2012, ch. 118); Young (2014, ch. 121); Young et al. (2016, ds 2, ch. 140); Ristevski et al. (2018, ds 2, ch. 193); Smith et al. (in review, ds 1, ch. 197); Ősi et al. (2018, ds 1, ch. 215); Foffa et al. (2019, ch. 219).* *State (1) occurs in Metasuchia (with reversals, such as in Crocodylia).* 0. absent 1. present
235	**Quadrate, contact with the proötics:** *Clark et al. (2000, ch. 14); Clark & Sues (2002, ch. 15); Sues et al. (2003, ch. 15); Clark et al. (2004, ch. 15); Nesbitt (2011, ch. 76); Pol et al. (2013, ch. 15); Young et al. (2016, ds 2, ch. 141); Leardi et al. (2017, ch. 15); Ristevski et al. (in review, ds 2, ch. 194); Smith et al. (2018, ds 1, ch. 198); Ősi et al. (2018, ds 1, ch. 216); Foffa et al. (2019, ch. 220).* *State (1) is a putative apomorphy of Crocodylomorpha.* 0. does not contact the proötic 1. contacts the proötic
236	**Quadrate, articulation of dorsal head contact:** *Clark (1994, ch. 47); Young & Andrade (2009, ch. 102 mod.); Andrade et al. (2011, ch. 298); Young et al. (2011, ch. 102 mod.); Young et al. (2013a, ch. 102 mod.); Young et al. (2012, ch. 119 mod.); Young (2014, ch. 122 mod.); Young et al. (2016, ds 2, ch. 142); Ristevski et al. (2018, ds 2, ch. 195); Smith et al. (in review, ds 1, ch. 199); Ősi et al. (2018, ds 1, ch. 217); Foffa et al. (2019, ch. 221).*

	State (1) is a putative apomorphy of Junggarsuchus + *Crocodyliformes.* 0. squamosal and exoccipital/opisthotic/otoccipital (can have medial contact with proötics and laterosphenoids) 1. proötic and laterosphenoid
237	**Quadrate, posterior margin:** *Nesbitt (2011, ch. 77); Young et al. (2016, ds 2, ch. 143); Ristevski et al. (2018, ds 2, ch. 196); Smith et al. (in review, ds 1, ch. 200); Ősi et al. (2018, ds 1, ch. 218); Foffa et al. (2019, ch. 222).* *State (1) is a putative apomorphy of Metasuchia – note that the ventral/anteroventral margins of the distal ends of the paroccipital processes have a strong sutural contact with the quadrates.* 0. does not have a sutural contact with the paroccipital process of the opisthotic, or the anterior margin of the paroccipital process has a simple contact with the posterior margin of the quadrate 1. has a robust sutural contact with the paroccipital process of the opisthotic
238	**Quadrate, anteroventral process suturing to the braincase:** *Young et al. (2013a, ch. 103 mod.); Young et al. (2012, ch. 120 mod.); Young (2014, ch. 123 mod.); Young et al. (2016, ds 2, ch. 144 mod.); Ristevski et al. (2018, ds 2, ch. 197); Smith et al. (in review, ds 1, ch. 201); Ősi et al. (2018, ds 1, ch. 219); Foffa et al. (2019, ch. 223).* *The scores for the contact of the anteroventral process (referred to as the 'orbital' and 'pterygoid' processes by different authors).* *State (2) represents the 'quadrate incompletely sutured to the braincase' statement in Holliday & Witmer (2009), Jouve (2009) and Fernández et al. (2011).* *The current version of this character aims to quantify two trends: 1) the contact between the quadrate and the laterosphenoid (as part of the stabilisation of the crocodylomorph skull), and 2) the thalattosuchian modification of this trend. In Thalattosuchia, it appears as though the anteromedial region of this process no longer articulates with the lateral surface of the neurocranium, but it is still elongated enough to have, and seems to sit lateral to the laterosphenoid. Perhaps suggesting a soft-tissue contact.* *State (1) occurs in Crocodyliformes.* *State (2) occurs in Thalattosuchia.* 0. this process contacts the pterygoid, but little to no contact with the neurocranium 1. this process has extensive contact with the laterosphenoid, basisphenoid and pterygoid (i.e. stabilises the splanchnocranium with the palate and neurocranium) 2. this process is free of bony attachment along its anteromedial surface, but ventrally contacts the pterygoid. Process likely has a posteromedial contact with the basisphenoid, but is free of contact with the laterosphenoid
239	**Quadrate, distal articular surface separated into two condyles:** *Young (2014, ch. 126); Young et al. (2016, ds 2, ch. 147); Ristevski et al. (2018, ds 2, ch. 200); Smith et al. (in review, ds 1, ch. 204); Ősi et al. (2018, ds 1, ch. 222); Foffa et al. (2019, ch. 224).* *State (1) is a putative apomorphy of Plesiosuchina.* *Character can be scored if the articular is preserved, and no ridge that supports the intercondylar sulcus is present.* 0. yes 1. no
240	**Quadrate-quadratojugal, quadratojugal contributes to the upper jaw joint along with the quadrate (i.e. helps to form the lateral hemicondyle):** *Jouve et al. (2005b, ch. 19 mod.); Jouve et al. (2008, ch. 19 mod.); Hastings et al. (2010, ch. 60 mod.); Ristevski et al. (2018, ds 2, ch. 201); Smith et al. (in review, ds 1, ch. 205); Ősi et al. (2018, ds 1, ch. 223); Foffa et al. (2019, ch. 226).* 0. lateral hemicondyle solely formed by the quadrate 1. lateral hemicondyle has a quadratojugal contribution
241	**Fossa for the tympanic membrane, anterior extension:**

	Ristevski et al. (2018, ds 2, ch. 202); Smith et al. (in review, ds 1, ch. 206); Ősi et al. (2018, ds 1, ch. 224). *State (1) occurs in Notosuchia and Sebecia.* *State (2) occurs in Neosuchia.* 0. limited to the squamosal 1. reaches the posterior margin of the postorbital 2. broadly exposed on the postorbital (covering the anterolateral margin) 3. crosses the postorbital and reaches the orbit
242	**Cranioquadrate canal, contact between the quadrate and exoccipital around the opening: (ORDERED)** *Clark (1994, ch. 49 mod.); Andrade et al. (2011, ch. 306 mod. + ch. 308 mod.); Ristevski et al. (2018, ds 2, ch. 203); Smith et al. (in review, ds 1, ch. 207); Ősi et al. (2018, ds 1, ch. 225); Foffa et al. (2019, ch. 227).* *Cranioquadrate canal (=quadratosquamosootoccipitalis, in Salisbury et al., 1999; or =quadratosquamosoexoccipitalis, in Delfino et al., 2008).* *State (1) occurs in Hallopodidae* (*e.g.* Almadasuchus) *and Mesoeucrocodylia.* *In derived forms the squamosal will also help enclose the cranioquadrate canal.* *Contact between quadrate and exoccipital is extensive (2) in all crown crocodylians, but in all stem metasuchians this contact is feeble (1).* 0. absent (and the quadrate and exoccipital do not meet to enclose the cranioquadrate canal) 1. lateral contact between the quadrate and exoccipital is feeble, but these bones do meet to enclose the cranioquadrate canal 2. lateral contact between the quadrate and exoccipital is broad, and these bones do meet to enclose the cranioquadrate canal
243	**Cranioquadrate canal, bones enclosing:** *Ristevski et al. (2018, ds 2, ch. 204); Smith et al. (in review, ds 1, ch. 208); Ősi et al. (2018, ds 1, ch. 226); Foffa et al. (2019, ch. 228).* *Scores for a similar morphology as Andrade et al. (2011, ch. 307), but with distinct differences.* *Cranioquadrate canal does not imply in the presence of a passage, and therefore may be opened laterally. The canal is only considered absent (0) in basal crocodylomorphs and basal crocodyliforms.* *Note at present state (0) here correlates with the state (0) in character quantifying the contact between the quadrate and exoccipital around the cranioquadrate canal. However, here a taxon with an enclosed cranioquadrate canal which does not have a squamosal participation would be scored as (0).* *State (1) occurs in Thalattosuchia.* *State (2) is common among goniopholidids and pholidosaurids.* *State (3) occurs in Metasuchia, but with some losses (especially in Neosuchia).* 0. quadrate, squamosal and exoccipital do not enclose the cranioquadrate canal along its length 1. squamosal laterally encloses the cranioquadrate canal, the quadrate ventrally, and the exoccipital posteriorly, medially and partly ventrally encloses the canal. This results in the canal opening laterally and/or posterolaterally 2. quadrate and squamosal do not laterally enclose the cranioquadrate canal, and it is laterally exposed but still exits on the occipital surface. *This looks to be a modification of state (3), where there is no ossified lateral enclosure, resulting in the 'open morphotype'*. 3. quadrate and squamosal laterally enclose the cranioquadrate canal, and the exoccipital helps enclose it dorsally. This results in the canal opening on the occipital surface
244	**Cranioquadrate canal, presence of a squamosal descending process separating the cranioquadrate canal from the external auditory meatus:** *Ristevski et al. (2018, ds 2, ch. 205); Smith et al. (in review, ds 1, ch. 209); Ősi et al. (2018, ds 1, ch. 227); Foffa et al. (2019, ch. 229).*

	State (1) occurs in thalattosuchians. Note that the Teleosaurus cadomensis *specimen figured by Jouve (2009) had a broken squamosal descending lamina, and that the skull had been acid prepared. Here it is scored as (1).* Pelagosaurus typus *is also scored as (1), as the skull NHMUK PV OR 32599 is also acid prepared and many of the thin laminae are broken.* 0. absent, no clear separation of these structures 1. present, the cranioquadrate canal and the external auditory meatus are distinct openings, sharing a common wall (squamosal descending process)

Mandibular geometry (Ch. 245 – 252; 1.629% of characters)

#	Description
245	**Mandible geometry, relative positions of the dentary tooth-row and coronoid process, and development of dorsal curvature of the posterior-end of the mandible:** *Young et al. (2011, ch. 167); Young et al. (2013a, ch. 109); Young et al. (2012, ch. 127); Young (2014, ch. 131); Young et al. (2016, ds 2, ch. 153); Ristevski et al. (2018, ds 2, ch. 207); Smith et al. (in review, ds 1, ch. 211); Ősi et al. (2018, ds 1, ch. 229); Foffa et al. (2019, ch. 230).* *State (1) is a putative apomorphy of Metriorhynchidae.* *Quantifies the incipient increase of gape at the base of Metriorhynchidae.* 0. gentle curvature, or no curvature, in the dorsal margin of the mandible, from the coronoid process to the end of the tooth-row 1. strong curvature, raising the coronoid process considerably above the tooth-row
246	**Mandible geometry, relative positions of coronoid process, retroarticular process and glenoid fossa:** *Young et al. (2011, ch. 168); Young et al. (2013a, ch. 110); Young et al. (2012, ch. 128); Young (2014, ch. 132); Young et al. (2016, ds 2, ch. 154); Ristevski et al. (2018, ds 2, ch. 208); Smith et al. (in review, ds 1, ch. 212); Ősi et al. (2018, ds 1, ch. 230); Foffa et al. (2019, ch. 231).* *State (1) is a putative apomorphy of Geosaurini.* *This character quantifies the greater increase in gape associated with macrophagous geosaurines.* 0. coronoid process level to both the retroarticular process and glenoid fossa 1. coronoid process ventral to both the retroarticular process and glenoid fossa
247	**Mandibular rami, presence of a sharp dorsal inclination:** *Ristevski et al. (2018, ds 2, ch. 209); Smith et al. (in review, ds 1, ch. 213); Ősi et al. (2018, ds 1, ch. 231); Foffa et al. (2019, ch. 232).* *State (1) is a putative apomorphy of Plesiosuchina.* 0. absent 1. present - immediately posterior to the mandibular symphysis the mandible sharply rises dorsally such that the ventral margin of the dentary (along with angular) is dorsally deflected (resulting in a distinct 'kink' along the mandibular ventral margin)
248	**Mandible, orientation of hemimandibles at their medial contact:** *Andrade et al. (2011, ch. 320); Ristevski et al. (2018, ds 1, ch. 320); Smith et al. (in review, ds 2, ch. 320); Ősi et al. (2018, ds 1, ch. 232); Foffa et al. (2019, ch. 233).* 0. evidently acute angle, hemimandibles meet at approximately 45 degrees of each other, or less 1. broad angle, hemimandibles meet at approximately 70 degrees of each other, or more
249	**Mandible, morphology of distal rami in dorsal/ventral views:** *Andrade et al. (2011, ch. 321); Ristevski et al. (2018, ds 2, ch. 210); Smith et al. (in review, ds 1, ch. 214); Ősi et al. (2018, ds 1, ch. 233); Foffa et al. (2019, ch. 234).* *Note that the broad-Y shape in (1) is not the result of elongation of the symphysis (which is present, but not exclusively in these forms), but by the arched distal rami, meeting at mid-mandible.*

	State (1) is putative apomorphy of Notosuchidae + Sphagesauridae. 0. distal rami mostly straight or poorly curved 1. distal rami strongly curved medially at mid-mandible, giving the mandible a broad-Y shape
250	**Mandible, ventral border at angular, in lateral view: (ORDERED)** *Andrade et al. (2011, ch. 322); Ristevski et al. (2018, ds 1, ch. 322); Smith et al. (in review, ds 2, ch. 322); Ősi et al. (2018, ds 1, ch. 234); Foffa et al. (2019, ch. 235). This character, created by Andrade et al. (2011), is potentially co-dependent with Pol et al. (2012, ch. 280), which is not included here (see also Turner & Buckley 2008, ch. 280)* *State (0) is based on descriptions by Woodward (1896), Price (1945) and Andrade & Bertini (2008b). State (2) is originally based on descriptions by Hooley (1907), Schwarz (2002) and Ősi et al. (2007).* 0. angular straight and mostly horizontal, or poorly curved, from the anterior to the posterior end 1. angular evidently (but gently) curved 2. angular abruptly curved, always below glenoid fossa, with mid-posterior sections of angular sub-vertical, facing posteriorly
251	**Mandible, morphology of ventral margin, in lateral view:** *Andrade et al. (2011, ch. 323); Ristevski et al. (2018, ds 1, ch. 323); Smith et al. (in review, ds 2, ch. 323); Ősi et al. (2018, ds 1, ch. 235); Foffa et al. (2019, ch. 236). The triple contact between dentary, angular and surangular can be taken as reference, if mandibular fenestra is absent* 0. mandible is curved ventrally, with maximum curvature at anterior section of angular, below the mandibular fenestra (when present), or not curved at all 1. mandible is curved posteroventrally, with maximum curvature at posterior section of angular, below (or almost below) the mandibular glenoid fossa, usually posterior to mandibular fenestra (when present)
252	**Mandible, dorsal border at dentary-surangular contact, in lateral view:** *Clark (1994, ch. 74); Sereno et al. (2003, ch. 41); Andrade et al. (2011, ch. 324); Ristevski et al. (2018, ds 1, ch. 324); Smith et al. (in review, ds 2, ch. 324); Ősi et al. (2018, ds 1, ch. 236); Foffa et al. (2019, ch. 237).* *State (2) is putative apomorphy of Notosuchidae + Sphagesauridae + Comahuesuchidae.* 0. mostly straight 1. gently arched dorsally 2. strongly arched dorsally

Mandible (Ch. 253 – 286; 6.924% of characters)
[Dermatocranium mandibular series (= ossa dentalia, ossa splenialia, ossa angularia, ossa supraangularia, ossa præarticularia, ossa coronoidea); and the mandibular contribution of the splanchnocranium (= ossa articularia and cartilagines meckeli)]

#	Description
253	**Anterior mandible (dentary), dorsal margin of the anterior portion compared to the dorsal margin of the posterior portion:** *Nesbitt (2011, ch. 154); Young et al. (2012, ch. 129); Young (2014, ch. 133); Young et al. (2016, ds 2, ch. 155); Ristevski et al. (2018, ds 2, ch. 211); Smith et al. (in review, ds 1, ch. 215); Ősi et al. (2018, ds 1, ch. 237); Foffa et al. (2019, ch. 238).* 0. horizontal (in the same plane) 1. ventrally deflected 2. dorsally expanded
254	**Anterior mandible (dentary), in dorsal or ventral view:** *Young et al. (2011, ch. 181 mod.); Young et al. (2013a, ch. 111 mod.); Young et al. (2012, ch. 130 mod.); Young (2014, ch. 135 mod.); Young et al. (2016, ds 2, ch. 156*

	mod.); Ristevski et al. (2018, ds 2, ch. 212); Smith et al. (in review, ds 1, ch. 216); Ősi et al. (2018, ds 1, ch. 238); Foffa et al. (2019, ch. 239). *Note, Ristevski et al. (2018, ds 2) added two new character states. These where added to determine whether the 'spatulate' anterior dentary morphotypes would homologous.* *State (1) occurs in most pholidosaurids, and in some dyrosaurids and eusuchians.* *State (2) is a putative apomorphy of Teleosauroidea.* *State (3) is a putative apomorphy of* Sarcosuchus *and* Chalawan. 0. outer margin converging towards tip or parallel 1. distinct spatulate shape, with the maximum transverse width at the D2 alveoli 2. distinct spatulate shape, with the maximum transverse width at the D3-D4 couplet 3. distinct spatulate shape, with the maximum transverse width at the D4 alveoli
255	**Anterior mandible (dentary), in dorsal or ventral view:** *Young et al. (2016, ds 2, ch. 157 + 158); Ristevski et al. (2018, ds 2, ch. 213); Smith et al. (in review, ds 1, ch. 217); Ősi et al. (2018, ds 1, ch. 239); Foffa et al. (2019, ch. 240).* *State (1) occurs in basal dyrosaurids and tomistomine crocodyloids*. *State (2) occurs in* Hamadasuchus, *Peirosauridae and* Baurusuchus. *States (1) and (2) differ in that the 'trowel'-shape has a shorter, broader and deeper symphyseal region; the anteriorly tapering maximal anterior width is more pronounced, and the width at the posterior symphyseal region is greater than the maximal anterior width.* 0. non-'gladius', or 'trowel'-shaped 1. 'gladius'-shaped - i.e. a long symphyseal region with the anterior maximal width near the D3–D5 region, with the dentaries tapering anteriorly. Immediately posterior to the maximal width, the dentaries begin to narrow until they reach a minimal width, and begin expanding again. At the end of the symphyseal region the breadth is now wider than the anterior maximal width 2. 'trowel'-shaped - i.e. a moderate to short symphyseal region with the anterior maximal width near the D3–D5 region, with the dentaries tapering strongly anteriorly. Immediately posterior to the maximal width the dentaries begin to narrow until they reach a minimal width, and begin expanding again. At the end of the symphyseal region the breadth is either narrower or subequal to the anterior maximal width
256	**Mandibular symphysis, length:** *Young (2006, ch. 20 mod.); Wilkinson et al. (2008, ch. 43 mod.); Young & Andrade (2009, ch. 43 mod.); Young et al. (2011, ch. 43 mod.); Young et al. (2013a, ch. 112 mod.); Young et al. (2012, ch. 132); Young (2014, ch. 136); Young et al. (2016, ds 2, ch. 159); Ristevski et al. (2018, ds 2, ch. 214); Smith et al. (in review, ds 1, ch. 218); Ősi et al. (2018, ds 1, ch. 240); Foffa et al. (2019, ch. 241).* 0. symphysis less than a third of mandible length (lower than 0.3) 1. symphysis less than half and more than a third of mandible length (between 0.3 and 0.45) 2. symphysis under half of mandible length (between 0.45 and 0.5) 3. symphysis greater than half of mandible length (more than 0.5)
257	**Mandibular symphysis, depth:** *Young (2006, ch. 21); Wilkinson et al. (2008, ch. 44); Young & Andrade (2009, ch. 44); Young et al. (2011, ch. 44); Young et al. (2013a, ch. 113); Young et al. (2012, ch. 133); Young (2014, ch. 137); Young et al. (2016, ds 2, ch. 160); Ristevski et al. (2018, ds 2, ch. 215); Smith et al. (in review, ds 1, ch. 219); Ősi et al. (2018, ds 1, ch. 241); Foffa et al. (2019, ch. 242).* 0. deep (9% or more of mandible length) 1. moderate (6.5–8% of mandible length) 2. narrow (4.5–6% of mandible length) 3. very narrow (4% or less of mandible length)
258	**External mandibular fenestra, presence:**

	Clark (1994, ch. 75 mod.); Ortega et al. (2000, ch. 80 rev.); Young (2006, ch. 22 part); Wilkinson et al. (2008, ch. 45 part); Young & Andrade (2009, ch. 45 part); Andrade et al. (2011, ch. 312); Young et al. (2011, ch. 45 part); Young et al. (2013a, ch. 114 part); Young et al. (2012, ch. 134 part); Young (2014, ch. 138 part); Young et al. (2016, ds 2, ch. 161 part); Ristevski et al. (2018, ds 1, ch. 312); Smith et al. (in review, ds 2, ch. 312); Ősi et al. (2018, ds 1, ch. 242); Foffa et al. (2019, ch. 243). State (0) occurs in Gobiosuchidae, Hylaeochampsidae, Bernissartiidae, Paralligatoridae and Metriorhynchidae. Also in derived goniopholidids (e.g. Anteophthalmosuchus *and* Goniopholis *sensu stricto – Andrade et al., 2011), derived pholidosaurids (*Oceanosuchus *and* Terminonaris browni*), and within Dyrosauridae (*Sabinosuchus*).* 0. absent 1. present as a diminutive passage 2. present as an evident fenestra
259	**External mandibular fenestra, shape: (*)** *Andrade et al. (2011, ch. 315); Ristevski et al. (2018, ds 1, ch. 315); Smith et al. (in review, ds 2, ch. 315); Ősi et al. (2018, ds 1, ch. 243); Foffa et al. (2019, ch. 244). This character is not applicable for taxa that lack external mandibular fenestrae.* 0. subcircular to poorly elliptic 1. highly elliptic, anteroposterior axis much longer than dorso-ventral axis, three time or more, but both ends rounded 2. slit-like, proportionally very long and both ends acute 3. broad teardrop-like 4. narrow teardrop-like 5. triangle
260	**External mandibular fenestra, morphology of anterior margin: (*)** *Andrade et al. (2011, ch. 316); Ristevski et al. (2018, ds 1, ch. 316); Smith et al. (in review, ds 2, ch. 316); Ősi et al. (2018, ds 1, ch. 244); Foffa et al. (2019, ch. 245). State (1) is present in peirosaurids,* Araripesuchus *and closely related taxa. Note that* Baurusuchus *was reconstructed as (1), but is actually (0). This character is not applicable for taxa that lack external mandibular fenestrae.* 0. curved, with a broad arched margin anteriorly 1. anterodorsal and anteroventral margins poorly arched, meeting at an acute angle anteriorly, anterior end is wedge-like
261	**Surangular foramen, presence:** *Clark et al. (2004 mod.); Nesbitt (2007 mod.); Nesbitt (2011, ch. 163); Ősi et al. (2018, ds 1, ch. 245); Foffa et al. (2019, ch. 246). State (1) is a putative apomorphy of* Junggarsuchus. *The foramen is located posterior to the external mandibular fenestra, and is surrounded by the surangular.* 0. present and small 1. present and large 2. absent
262	**Dentary, ventral margin strongly curved:** *Young et al. (2016, ds 2, ch. 162 + 163); Ristevski et al. (2018, ds 2, ch. 217); Smith et al. (in review, ds 1, ch. 221); Ősi et al. (2018, ds 1, ch. 246); Foffa et al. (2019, ch. 247). State (1) occurs in* Junggarsuchus, Dakosaurus, Baurusuchus, *and in 'trematochampsids' and peirosaurids. State (2) occurs in* Pachycheilosuchus + Pietraroiasuchus*.* 0. no 1. yes, ventral margin is distinctly curved (convex). It rises sharply dorsally towards the anterior tip (this curvature occurs along the anterior ventral margin of the dentary) 2. yes, ventral margin is curved (concave). It rises dorsally towards the anterior tip (this curvature occurs along the anterior ventral margin of the dentary, from a

	dorsoventrally deepened region of the dentary, immediately anterior to the dentary-splenial suture)
263	**Dentary foramina, lateral and dorsal surface of the anterior (symphyseal) region of the dentary:** *Young et al. (2016, ds 2, ch. 164); Ristevski et al. (2018, ds 2, ch. 218); Smith et al. (in review, ds 1, ch. 222); Ősi et al. (2018, ds 1, ch. 247); Foffa et al. (2019, ch. 248).* *State (1) is a putative apomorphy of* Dakosaurus*.* 0. foramina either small or variable in size. Number is variable. 1. has numerous small to medium-sized foramina
264	**Surangulodentary groove, morphology:** *Young (2006, ch. 23 mod.); Wilkinson et al. (2008, ch. 46 part); Young & Andrade (2009, ch. 46 part); Young et al. (2011, ch. 46 part); Young et al. (2013a, ch. 115 part); Young et al. (2012, ch. 135); Young (2014, ch.139); Young et al. (2016, ds 2, ch. 166); Ristevski et al. (2018, ds 2, ch. 220); Smith et al. (in review, ds 1, ch. 224); Ősi et al. (2018, ds 1, ch. 248); Foffa et al. (2019, ch. 249).* *Note taphonomic or preservational damage can obscure state (1).* *State (2) is a putative apomorphy of the clade Geosaurini. Previously it was considered an apomorphy of* Dakosaurus*; however, the type specimens for the genera* Dakosaurus, Plesiosuchus *and* Geosaurus *share this morphology. The deep groove is also observed in the holotype of* Torvoneustes coryphaeus*, and large specimens of* Tyrannoneustes lythrodectikos*.* 0. absent 1. present as a subtle, shallow groove 2. deeply excavated
265	**Surangulodentary groove, relative length on both elements: (*)** *Young et al. (2013a, ch. 115 part); Young et al. (2012, ch. 136); Young (2014, ch. 140); Young et al. (2016, ds 2, ch. 167); Ristevski et al. (2018, ds 2, ch. 221); Smith et al. (in review, ds 1, ch. 225); Ősi et al. (2018, ds 1, ch. 249); Foffa et al. (2019, ch. 250).* *This character is not applicable for taxa that lack the surangulodentary groove.* 0. groove is longer on the dentary than on the surangular 1. groove is as long on the dentary as on the surangular
266	**Surangulodentary groove, large foramen present at the dentary terminus: (*)** *Wilkinson et al. (2008, ch. 46 part); Young & Andrade (2009, ch. 46 part); Young et al. (2011, ch. 190); Young et al. (2013a, ch. 116); Young et al. (2012, ch. 137); Young (2014, ch. 141); Young et al. (2016, ds 2, ch. 168); Ristevski et al. (2018, ds 2, ch. 222); Smith et al. (in review, ds 1, ch. 226); Ősi et al. (2018, ds 1, ch. 250); Foffa et al. (2019, ch. 251).* *This character is not applicable for taxa that lack the surangulodentary groove.* *State (1) is a putative apomorphy of* Dakosaurus*.* 0. absent 1. present
267	**Mandibular grooves, morphology along the dentary in lateral view: (*)** *Smith et al. (in review, ds 1, ch. 227); Ősi et al. (2018, ds 1, ch. 251); Foffa et al. (2019, ch. 252).* *This character is not applicable for taxa that lack the surangulodentary groove.* *State (1) occurs in basal metriorhynchoids.* 0. the surangulodentary and angulodentary grooves are either poorly developed, not elongate, converge towards one another (i.e. they are not parallel, and close to one another ventral to the dentary rami tooth row 1. the surangulodentary and angulodentary grooves are parallel and positioned close to one another ventral to the dentary rami tooth row

268	**Splenial, involvement in mandibular symphysis:** *Young (2006, ch. 25 mod.); Wilkinson et al. (2008, ch. 49 mod.); Young & Andrade (2009, ch. 49 mod.); Young et al. (2011, ch. 49 mod.); Young et al. (2013a, ch. 117 mod.); Young et al. (2012, ch. 138 mod.); Young (2014, ch. 142); Young et al. (2016, ds 2, ch. 169 mod.); Ristevski et al. (2018, ds 2, ch. 223); Smith et al. (in review, ds 1, ch. 228); Ősi et al. (2018, ds 1, ch. 252); Foffa et al. (2019, ch. 253).* 0. slight (less than 10% of symphysis length) 1. extensive (greater than, or equal to, 15% of symphysis length) 2. not involved
269	**Splenials, in dorsal view, excavation of Meckelian groove on dorsal surface of symphyseal splenials: (NEW)** *State (1) occurs in* Neosteneosaurus edwardsi*,* Proexochokefalos heberti *and Machimosaurini.* 0. deep 1. shallow/absent
270	**Angular, in lateral view, dorsal curvature: (NEW)** *State (1) occurs in* Proexochokefalos heberti*,* Neosteneosaurus edwardsi *and Machimosaurini.* 0. gradual 1. sharp and abrupt
271	**Angular, in lateral view, extension of the anterior lateral ramus:** *Young (2006, ch. 24 part); Wilkinson et al. (2008, ch. 47 part); Young & Andrade (2009, ch. 47 part); Young et al. (2011, ch. 47 part); Young et al. (2013a, ch. 118 part); Young et al. (2012, ch. 139); Young (2014, ch. 143); Young et al. (2016, ds 2, ch. 170); Ristevski et al. (2018, ds 2, ch. 224); Smith et al. (in review, ds 1, ch. 229); Ősi et al. (2018, ds 1, ch. 253); Foffa et al. (2019, ch. 254).* 0. short, does not extend beyond the orbits 1. long, does extend anteriorly beyond the orbits
272	**Angular, in lateral view, posterodorsal extension:** *Jouve et al. (2008, ch. 39 mod.); Hastings et al. (2010, ch. 79 mod.); Ristevski et al. (2018, ds 2, ch. 225); Smith et al. (in review, ds 1, ch. 230); Ősi et al. (2018, ds 1, ch. 254); Foffa et al. (2019, ch. 255).* 0. reaches the retroarticular process (or posterior end of the mandible if the retroarticular process is not present) 1. does not reach the retroarticular process
273	**Surangular, in lateral view, extension of the anterior lateral ramus:** *Young (2006, ch. 24 part); Wilkinson et al. (2008, ch. 47 part); Young & Andrade (2009, ch. 47 part); Andrade et al. (2011, ch. 346 mod.); Young et al. (2011, ch. 47 part); Young et al. (2013a, ch. 118 part); Young et al. (2012, ch. 140); Young (2014, ch. 144); Young et al. (2016, ds 2, ch. 171); Ristevski et al. (2018, ds 2, ch. 226); Smith et al. (in review, ds 1, ch. 231); Ősi et al. (2018, ds 1, ch. 255); Foffa et al. (2019, ch. 256).* 0. short, does not extend anteriorly beyond the orbit 1. long, extends anteriorly beyond the orbit
274	**Surangular, along the dorsal margin of the mandible:** *Wilkinson et al. (2008, ch. 48); Young & Andrade (2009, ch. 48); Young et al. (2011, ch. 48); Young et al. (2013a, ch. 119); Young et al. (2012, ch. 141); Young (2014, ch. 145); Young et al. (2016, ds 2, ch. 172); Ristevski et al. (2018, ds 2, ch. 227); Smith et al. (in review, ds 1, ch. 232); Ősi et al. (2018, ds 1, ch. 256); Foffa et al. (2019, ch. 257).* *This character does not always covary with the previous character, as in non-Rhacheosaurini metriorhynchines the dentary extensively overlaps the surangular (particularly in lateral view), obscuring its anterior development. The full extent of the surangular anterior development can only be determined by examining the dorsal margin in those taxa (e.g.,* Metriorhynchus superciliosus*).* 0. does not extend anteriorly beyond the orbit 1. does extend anteriorly beyond the orbit

275	**Surangular, presence of a distinct coronoid process:** *Young & Andrade (2009, ch. 155); Young et al. (2011, ch. 155); Young et al. (2013a, ch. 120); Young et al. (2012, ch. 142); Young (2014, ch. 146); Young et al. (2016, ds 2, ch. 173); Ristevski et al. (2018, ds 2, ch. 228); Smith et al. (in review, ds 1, ch. 233); Ősi et al. (2018, ds 1, ch. 257); Foffa et al. (2019, ch. 258).* *In Crocodyliformes, state (1) occurs in Thalattosuchia and* Iharkutosuchus*.* *In Thalattosuchia it appears as though all taxa have a coronoid process. In teleosauroids the coronoid process is medially orientated and is not visible in lateral view, unlike in* Pelagosaurus + *Metriorhynchidae.* 0. absent 1. present
276	**Surangular, presence of extension to the retroarticular process:** *Norell (1988, ch. 42 mod.); Brochu (1999, ch. 51 rev.); Young & Andrade (2009, ch. 103); Andrade et al. (2011, ch. 350); Young et al. (2011, ch. 103); Young et al. (2013a, ch. 121); Young et al. (2012, ch. 143 mod.); Young (2014, ch. 147); Young et al. (2016, ds 2, ch. 174 mod.); Ristevski et al. (2018, ds 2, ch. 229); Smith et al. (in review, ds 1, ch. 234); Ősi et al. (2018, ds 1, ch. 258); Foffa et al. (2019, ch. 259).* 0. absent, pinched off anterior to tip of retroarticular process, or surangular excluded from process 1. present, extends to posterior end of retroarticular process (or posterior end of the ramus)
277	**Prearticulars, presence:** *Clark (1994, ch. 72 rev.); Sereno et al. (2003, ch. 39); Young & Andrade (2009, ch. 89); Andrade et al. (2011, ch. 354); Young et al. (2011, ch. 89); Young et al. (2013a, ch. 122); Young et al. (2012, ch. 144); Young (2014, ch. 148); Young et al. (2016, ds 2, ch. 175); Ristevski et al. (2018, ds 2, ch. 230); Smith et al. (in review, ds 1, ch. 235); Ősi et al. (2018, ds 1, ch. 259); Foffa et al. (2019, ch. 260).* *Note, here we follow Andrade et al. (2011) in scoring* Pholidosaurus schaumburgensis *and* Sarcosuchus imperator *as lacking prearticulars (as MTY also could not find these elements in first-hand observations). As such they are scored as (?).* *It is not possible to verify the potential prearticular in* Oceanosuchus *(Hua et al., 2007, Fig. 4U) as too much of the angular is not preserved. Thus, this OTU is scored as (?).* *State (1) occurs in Metasuchia.* 0. present 1. absent
278	**Coronoids:** *Jouve et al. (2005b, ch. 6 mod.); Jouve et al. (2008, ch. 6 mod.); Young & Andrade (2009, ch. 157 part); Hastings et al. (2010, ch. 77 mod.); Young et al. (2011, ch. 157 part); Young et al. (2013a, ch. 124 part); Young et al. (2012, ch. 146 part); Young (2014, ch. 150 part); Young et al. (2016, ds 2, ch. 177 part); Ristevski et al. (2018, ds 2, ch. 231); Smith et al. (in review, ds 1, ch. 236); Foffa et al. (2019, ch. 261).* *This character is an amalgam of those in Hastings et al. (2010, ch. 77) and Young et al. (2016, ch. 177); Ősi et al. (2018, ds 1, ch. 260).* *State (1) occurs in derived Rhacheosaurini metriorhynchids.* *Dyrosaurids have state (2). However, to evaluate the presence of the coronoids requires well preserved specimens.* 0. present, but not exposed on the external (= lateral) surface of the mandible 1. present, and exposed on the external surface of the mandible 2. absent
279	**Coronoid, anterior development along the dorsal margin:** *Wilkinson et al. (2008, ch. 51 mod.); Young & Andrade (2009, ch. 51 mod.); Young et al. (2011, ch. 51 mod.); Young et al. (2013a, ch. 123 mod.); Young et al. (2012, ch. 145 mod.); Young (2014, ch. 149); Young et al. (2016, ds 2, ch. 176 mod.);*

	Ristevski et al. (2018, ds 2, ch. 232); Smith et al. (in review, ds 1, ch. 237); Ősi et al. (2018, ds 1, ch. 261); Foffa et al. (2019, ch. 262). 0. does not project as far as the dentary tooth row, or coronoid absent 1. projects further anteriorly than the posterior-most alveoli
280	**Articular, glenoid fossa orientation:** *Young & Andrade (2009, ch. 154); Young et al. (2011, ch. 154); Young et al. (2013a, ch. 125); Young et al. (2012, ch. 147); Young (2014, ch. 151); Young et al. (2016, ds 2, ch. 178); Ristevski et al. (2018, ds 2, ch. 233); Smith et al. (in review, ds 1, ch. 238); Ősi et al. (2018, ds 1, ch. 263). Foffa et al. (2019, ch. 263).* 0. anterodorsally 1. dorsally
281	**Retroarticular process, development:** *Clark (1994, ch. 71 part); Andrade et al. (2011, ch. 358); Ristevski et al. (2018, ds 2, ch. 234); Smith et al. (in review, ds 1, ch. 239); Ősi et al. (2018, ds 1, ch. 263); Foffa et al. (2019, ch. 264).* *For practical purposes, a retroarticular process is here considered as (1) when its orientation can be established.* *State (1) occurs in Mesoeucrocodylia.* 0. absent or poorly developed 1. present and evidently projecting posterior to glenoid fossa
282	**Retroarticular process, length of the attachment surface for the adductor muscles relative to its width: (*) (ORDERED)** *Jouve et al. (2005, ch. 1 mod.); Jouve et al. (2008, ch. 1 mod.), Andrade et al. (2011, ch. 359); Hastings et al. (2010, ch. 75 mod.); Ristevski et al. (2018, ds 2, ch. 235); Smith et al. (in review, ds 1, ch. 240); Ősi et al. (2018, ds 1, ch. 264); Foffa et al. (2019, ch. 265).* *State (2) is a putative apomorphy of Dyrosauridae. Note, that in dyrosaurids the retroarticular processes also have a strong posterodorsal curvature.* *This character is not applicable for taxa that lack retroarticular processes.* 0. short, subequal 1. moderately elongated, evidently longer than wide 2. extremely elongate, more than twice its width
283	**Retroarticular process, morphology of the surface for the attachment of adductor muscles: (*)** *Wilkinson et al. (2008, ch. 50 mod.); Young & Andrade (2009, ch. 50 mod.); Andrade et al. (2011, ch. 363); Young et al. (2011, ch. 50 mod.); Young et al. (2013a, ch. 126 mod.); Young et al. (2012, ch. 148 mod.); Young (2014, ch. 152 mod.); Young et al. (2016, ds 2, ch. 179 mod.); Ristevski et al. (2018, ds 2, ch. 236); Smith et al. (in review, ds 1, ch. 241); Ősi et al. (2018, ds 1, ch. 265); Foffa et al. (2019, ch. 266).* *This character is not applicable for taxa that lack retroarticular processes.* 0. triangular 1. ellipsoid, rectangular or spoon-shaped 2. shovel-shaped (or paddle-shaped)
284	**Retroarticular process, width: (*)** *Young & Andrade (2009, ch. 152); Young et al. (2011, ch. 152); Young et al. (2013a, ch. 127); Young et al. (2012, ch. 149); Young (2014, ch. 153); Young et al. (2016, ds 2, ch. 180); Ristevski et al. (2018, ds 2, ch. 237); Smith et al. (in review, ds 1, ch. 242); Ősi et al. (2018, ds 1, ch. 266); Foffa et al. (2019, ch. 267).* *This character is not applicable for taxa that lack retroarticular processes.* 0. narrower than the glenoid fossa 1. wider than the glenoid fossa (projecting medially past the glenoid fossa)
285	**Retroarticular process, length: (*)** *Young & Andrade (2009, ch. 153); Young et al. (2011, ch. 153); Young et al. (2013a, ch. 128); Young et al. (2012, ch. 150); Young (2014, ch. 154); Young et al. (2016, ds 2, ch. 181); Ristevski et al. (2018, ds 2, ch. 238); Smith et al. (in review, ds 1, ch. 243); Ősi et al. (2018, ds 1, ch. 267); Foffa et al. (2019, ch. 268).*

	This character is not applicable for taxa that lack retroarticular processes. 0. long (longer than wide, and longer than the glenoid fossa width) 1. short (wider than long, and shorter than the glenoid fossa width)
286	**Retroarticular process, position of the posteromedial wing: (*)** *Jouve et al. (2005b, ch. 2); Jouve et al. (2008, ch. 2); Hastings et al. (2010, ch. 76); Andrade et al. (2011, ch. 365); Ristevski et al. (2018, ds 2, ch. 239); Smith et al. (in review, ds 1, ch. 244); Ősi et al. (2018, ds 1, ch. 268); Foffa et al. (2019, ch. 269).* *State (1) is a putative apomorphy of Dyrosauridae.* *This character is not applicable for taxa that lack retroarticular processes.* 0. posteromedial wing dorsally situated, or at mid height on the retroarticular process 1. posteromedial wing ventrally situated on the retroarticular process

Dentition and alveolar morphologies (Ch. 287 – 362; 14.867% of characters)

[Note abbreviations used in this section: P = premaxilla, M = maxilla, D = dentary. Thus, D1 would refer to the first dentary alveolus, while M4 would be the fourth maxillary alveolus, etc. Tooth count numbering starts from the anterior-most alveolus.]

#	Description
287	**Tooth row, premaxillary alveoli and posterior maxillary alveoli:** *Young & Andrade (2009, ch. 129); Young et al. (2011, ch. 129); Young et al. (2013a, ch. 3); Young et al. (2012, ch. 5); Young (2014, ch. 5); Young et al. (2016, ds 2, ch. 6), Ristevski et al. (2018, ds 2, ch. 13); Smith et al. (in review, ds 1, ch. 14); Ősi et al. (2018, ds 1, ch. 269); Foffa et al. (2019, ch. 270).* *State (1) is a putative apomorphy of Metriorhynchidae.* *Note that the ventral offset scored by this character is formed by the dorsoventral expansion of the orbits, this results in the ventroposterior curvature of the posterior maxillae (and thus the concave maxillary tooth row).* 0. upper tooth row largely in the same plane (excludes maxillary deflections) 1. posterior maxillary alveoli ventral to all other alveoli (caused by the ventroposterior curvature of the posterior maxillae)
288	**Premaxilla, alveolar count:** *Young (2006, ch. 26 mod.); Wilkinson et al. (2008, ch. 52 mod.); Young & Andrade (2009, ch. 52 mod.); Nesbitt (2011, ch. 6 mod.); Young et al. (2011, ch. 52 mod.); Young et al. (2013a, ch. 129 mod.); Young et al. (2012, ch. 151 mod.); Young (2014, ch. 155 mod.); Young et al. (2016, ds 2, ch. 182 mod.); Ristevski et al. (2018, ds 2, ch. 240 mod.); Smith et al. (in review, ds 1, ch. 245 mod.); Ősi et al. (2018, ds 1, ch. 270); Foffa et al. (2019, ch. 271).* *State (0) occurs in* Anatosuchus. *State (1) occurs in the teleosauroids* Bathysuchus megarhinus*,* Platysuchus multiscrobiculatus*,* Sericodon jugleri *and* Teleosaurus cadomensis. *State (3) occurs in* Machimosaurus. 0. six or more alveoli 1. five alveoli 2. four alveoli 3. three or fewer alveoli
289	**Maxilla, alveolar count:** *Young (2006, ch. 27 mod.); Wilkinson et al. (2008, ch. 53 mod.); Young & Andrade (2009, ch. 53 mod.); Young et al. (2011, ch. 53 mod.); Young et al. (2013a, ch. 130 mod.); Young et al. (2012, ch. 152 mod.); Young (2014, ch. 156); Young et al. (2016, ds 2, ch. 183); Ristevski et al. (2018, ds 2, ch. 241); Smith et al. (in review, ds 1, ch. 246); Ősi et al. (2018, ds 1, ch. 271); Foffa et al. (2019, ch. 272).* 0. 11 or fewer alveoli 1. 12–16 alveoli

	2. 17–20 alveoli 3. 21–28 alveoli 4. 29 or more alveoli
290	**Maxilla, end of the alveolar row:** *Ristevski et al. (2018, ds 2, ch. 242); Smith et al. (in review, ds 1, ch. 247); Ősi et al. (2018, ds 1, ch. 272); Foffa et al. (2019, ch. 273).* *State (0) occurs in Dyrosauridae.* *State (2) occurs in the metriorhynchid subclade* Tyrannoneustes lythrodectikos, Purranisaurus, Torvoneustes, 'Metriorhynchus' hastifer + *Mr. Passmore's specimen. It also occurs in Baurusuchidae,* Stolokrosuchus *and* Kaprosuchus + Mahajangasuchus*.* 0. maxillary tooth row terminates posterior to the posterior margin of the orbit, but does not extend beyond the anteroposterior mid-length of the supratemporal fenestrae 1. maxillary tooth row terminates level to, or posterior to, the anterior margin of the orbit 2. maxillary tooth row terminates prior to the anterior margin of the orbit
291	**Maxilla, presence of deep and pronounced reception pits: (*) (NEW)** *In state (0) some teleosauroids have noticeable reception pits in the anterior maxilla (such as* Deslongchampsina larteti, Neosteneosaurus edwardsi *and* Charitomenosuchus leedsi*), but they disappear by the middle of the maxilla*. *State (1) occurs in Machimosaurini.* 0. absent, reception pits are shallow throughout, or reception pits are conspicuous only in the anterior third of the maxilla and they gradually disappear at the mid-maxilla 1. present, reception pits are conspicuous throughout the anterior and mid-maxilla, and disappear towards the posterior-most maxilla
292	**Premaxilla, P1-P2 form a couplet: (*) (NEW)** *State (0) occurs in* Platysuchus multiscrobiculatus, Sericodon jugleri*,* Bathysuchus megarhinus *and* Mycterosuchus nasutus. *This character is not applicable for taxa that have fewer than four premaxillary alveoli.* 0. no: interalveolar spacing between P1-P2 and P3-P4 relatively the same size 1. yes: interalveolar spacing between P1-P2 and P3-P4 differs: P1-P2 separated by a thin lamina and P3-P4 well separated
293	**Premaxilla, P3-P4 form a couplet: (*) (NEW)** *State (1) occurs in the Chinese teleosauroid and* Bathysuchus megarhinus*.* *This character is not applicable for taxa that have fewer than four premaxillary alveoli.* 0. present 1. absent
294	**Premaxilla, in palatal view, orientation of premaxillary alveoli one (P1) and two (P2): (*) (NEW)** *State (1) occurs in* Charitomenosuchus leedsi *and* Proexochokefalos heberti. *State (2) occurs in* Bathysuchus megarhinus*,* Sericodon jugleri *and* Mycterosuchus nasutus. *This character is not applicable for taxa that have fewer than four premaxillary alveoli.* 0. both P1 and P2 oriented anteriorly 1. P1 oriented anteriorly, P2 oriented slightly medially 2. both P1 and P2 oriented laterally

295	**Premaxilla, P1 and P2 do not form a couplet but are still oriented to the anterior margin of the premaxilla: (*) (NEW)** *State (1) occurs in* Bathysuchus megarhinus*,* Sericodon jugleri *and* Mycterosuchus nasutus. *This character is not applicable for taxa that have fewer than four premaxillary alveoli, or for taxa that have the P1-P2 alveolar couplet.* 0. no 1. yes
296	**Premaxilla, strong lateral expansion so that P3 and P4 are aligned on the lateral plane of the external margin (more so than P2): (NEW)** *State (1) occurs in* Bathysuchus megarhinus *and* Sericodon jugleri. 0. absent 1. present
297	**Premaxilla, very small first premaxillary alveolus, with the second premaxillary alveolus being much larger (first premaxillary alveolus less than 25% size of second premaxillary alveolus): (*) (NEW)** *State (0) occurs in* Macrospondylus bollensis and *the Chinese teleosauroid.* *This character is not applicable for taxa that have fewer than four premaxillary alveoli.* 0. yes 1. no
298	**Premaxilla, P1 and P2 alveoli relative to one another:** *Modified based on Foffa et al. (2019).* *State (1) occurs in the teleosauroids* Aeolodon priscus*,* Sericodon jugleri*,* Bathysuchus megarhinus*, and* Mycterosuchus nasutus. *State (1) also occurs in Pholidosauridae.* *State (2) occurs in* Elosuchus*.* *Foffa et al. (in review, ch. 274).* 0. the P1 and P2 alveoli are not in the same plane, with the P2 alveolus being posterolateral 1. both alveoli are in the same transverse plane 2. the P2 alveolus is anterolateral to the P1 alveolus
299	**Premaxilla, shape of the anterior margin between the P2-P3 alveoli:** *Modified based on Foffa et al. (2019).* *State (1) occurs in* Aeolodon priscus*,* Sericodon jugleri*,* Bathysuchus megarhinus*, and* Mycterosuchus nasutus*.* *Note that this morphology does not occur in Pholidosauridae, which have a semi-circular shaped premaxilla in dorsal view. Thus, how the P1-P2 alveoli are in the same transverse plane and its structural implications for premaxillary shape differ between teleosauroids and pholidosaurids.* *Foffa et al. (in review, ch. 275).* 0. premaxilla lateral margins are clearly curved, with the P3 alveoli being either: in-line, posteromedial or posterolateral to the P2 alveoli 1. premaxilla lateral margins subrectangular, with the P3 alveoli being clearly lateral to the P2 alveoli (i.e. not part of a curving tooth-row)
300	**Third premaxillary alveoli, relative size when more than three premaxillary alveoli are present: (*)** *Hastings et al. (2010, ch. 16 mod.); Ristevski et al. (2018, ds 2, ch. 243); Smith et al. (in review, ds 1, ch. 248); Ősi et al. (2018, ds 1, ch. 273); Foffa et al. (2019, ch. 274).* *This character is not applicable for taxa that have fewer than four premaxillary alveoli.* 0. not enlarged relative to both the second and fourth premaxillary alveoli 1. third alveoli are enlarged relative to both adjacent alveoli
301	**Premaxilla, tooth row: (ORDERED)** *Sereno et al. (2001, ch. 69 mod.); Turner & Buckley (2008, ch. 240 mod.); Andrade et al. (2011, ch. 390 mod.); Young et al. (2016, ds 2, ch. 12 mod.), Ristevski et al.*

	(2018, ds 2, ch. 25); Smith et al. (in review, ds 1, ch. 26); Ősi et al. (2018, ds 1, ch. 274); Foffa et al. (2019, ch. 275). *State (2) occurs in the pholidosaurids* Chalawan, Sarcosuchus, Pholidosaurus schaumburgensis *(based on the German natural mould specimens) and* Meridiosaurus. *The morphology in* Elosuchus *and the French* Pholidosaurus *approaches this condition, however the P5 is directed posteriorly and the premaxilla has definitive lateral margins rather than a curved anterolateral curve (however, this could be due to the enlargement of the P3 alveoli). Here, we have created a new character state (1) to accommodate this morphology.* *State (3) is a modification seen in* Terminonaris *and* Oceanosuchus*.* 0. alveoli along the anterior and lateral margins 1. in a slight semi-circle, (similar to state 2), but the P5 alveolar are directly posteriorly, and the premaxilla still has definitive lateral margins rather than a true anterolateral curve 2. in a slight semi-circle, resulting in the premaxillary alveoli being restricted to the anterior and anterolateral margins 3. the premaxillary tooth row is restricted to an even tighter curve, resulting in the P5 alveoli being lateral to the P4 alveoli and being somewhat laterally oriented (compared to the other four alveoli). The tighter curve means the normally very transversely wide premaxilla of pholidosaurids is now much less wide (with the maximal width at the P5)
302	**Number of teeth partially supported by both the premaxilla and maxilla:** *Young & Andrade (2009, ch. 162); Young et al. (2011, ch. 162); Young et al. (2013a, ch. 131); Young et al. (2012, ch. 153); Young (2014, ch. 157); Young et al. (2016, ds 2, ch. 184); Ristevski et al. (2018, ds 2, ch. 244); Smith et al. (in review, ds 1, ch. 249); Ősi et al. (2018, ds 1, ch. 275); Foffa et al. (2019, ch. 276).* *State (1) occurs in* Mariliasuchus *and* Notosuchus. 0. none 1. one
303	**Presence of a premaxillary lamina extending posteriorly along the palatal surface that overlaps the anterior margin of the first maxillary alveoli:** *Ristevski et al. (2018, ds 2, ch. 245); Smith et al. (in review, ds 1, ch. 250); Ősi et al. (2018, ds 1, ch. 276); Foffa et al. (2019, ch. 277).* *State (1) occurs in* Tyrannoneustes lythrodectikos, Torvoneustes, 'Metriorhynchus' hastifer *and Mr. Passmore's specimen.* 0. absent 1. present
304	**Anterior margin of maxillary alveolus one:** *Ristevski et al. (2018, ds 2, ch. 246); Smith et al. (in review, ds 1, ch. 251); Ősi et al. (2018, ds 1, ch. 277); Foffa et al. (2019, ch. 278).* *State (1) occurs in* Metriorhynchus superciliosus *and* M. geoffroyii. 0. lacks an interdigitating suture with the premaxilla 1. has an interdigitating suture with the premaxilla, restricted to the anterior margin of the first maxillary alveolus
305	**Dentary, alveolar count:** *Young (2006, ch. 28 mod.); Wilkinson et al. (2008, ch. 54 mod.); Young & Andrade (2009, ch. 54 mod.); Young et al. (2011, ch. 54 mod.); Young et al. (2013a, ch. 132 mod.); Young et al. (2012, ch. 154); Young (2014, ch. 158); Young et al. (2016, ds 2, ch. 185); Ristevski et al. (2018, ds 2, ch. 247); Smith et al. (in review, ds 1, ch. 252); Ősi et al. (2018, ds 1, ch. 278); Foffa et al. (2019, ch. 279).* *This character does not covary with the maxillary alveolar count character, as some taxa (e.g.* 'Metriorhynchus' casamiquelai*) have more teeth in the dentary than in the maxilla.* 0. 30 or more alveoli per rami 1. 20–29 alveoli 2. 15–19 alveoli 3. 14 or fewer alveoli

306	**Maxillary anterior alveoli shape:** *Young et al. (2016, ds 2, ch. 186); Ristevski et al. (2018, ds 2, ch. 248); Smith et al. (in review, ds 1, ch. 253); Ősi et al. (2018, ds 1, ch. 279); Foffa et al. (2019, ch. 280).* *In Thalattosuchia, state (1) is a putative apomorphy of the clade* 'Metriorhynchus' hastifer *and Mr. Passmore's specimen.* *Note that shearing or crushing of the snout can make this character hard to discern.* 0. sub-circular 1. sub-oval, being wider transversely than anteroposteriorly
307	**Maxillary interalveolar spaces, relative size:** *Young (2014, ch. 159); Young et al. (2016, ds 2, ch. 187); Ristevski et al. (2018, ds 2, ch. 249); Smith et al. (in review, ds 1, ch. 254); Ősi et al. (2018, ds 1, ch. 280); Foffa et al. (2019, ch. 281).* *State (1) is a putative apomorphy of* Dakosaurus + Plesiosuchus *sub-clade and* Gracilineustes leedsi. *This character correlates with the dentary interalveolar space character for the metriorhynchids* Gracilineustes leedsi and *the* Dakosaurus + Plesiosuchus *sub-clade*; *however, the maxillary interalveolar spacing does not correlate with the dentary character for the teleosauroid* Machimosaurus hugii. *State (1) does not occur in* Torvoneustes carpenteri, 'Metriorhynchus' hastifer *and Mr. Passmore's specimen as some interalveolar spaces are large, over half the length of the adjacent alveoli and they do not always share the same alveolar lamina. They appear to evolve an analogous, but slightly different morphology, which has not yet been scored.* *State (1) also occurs in* Iharkutosuchus makadii. 0. interalveolar spaces are variable in size, some are similar in length to the adjacent alveoli, while others are approximately half the length of the immediately adjacent alveoli (especially towards the end of the maxillary tooth row) 1. interalveolar spaces are/almost completely uniformly narrow, being approximately one quarter the length of the adjacent alveoli (or even smaller). The adjacent alveoli share the same alveolar lamina.
308	**Dentary tooth-row, distinctly sigmoidal:** *Young et al. (2016, ds 2, ch. 165); Ristevski et al. (2018, ds 2, ch. 219); Smith et al. (in review, ds 1, ch. 223); Ősi et al. (2018, ds 1, ch. 281); Foffa et al. (2019, ch. 282).* *State (1) occurs in Hylaeochampsidae.* 0. no 1. yes, with the anterior alveoli orientated slightly anterolaterally and the posterior alveoli orientated posteromedially, between these two orientations the mid-region alveoli become dorsally orientated
309	**Dentary alveoli one, orientation:** *Young et al. (2016, ds 2, ch. 188); Ristevski et al. (2018, ds 2, ch. 250); Smith et al. (in review, ds 1, ch. 255); Ősi et al. (2018, ds 1, ch. 282); Foffa et al. (2019, ch. 283).* *State (1) occurs in Tethysuchia (e.g. dyrosaurids,* Sarcosuchus, Chalawan) *and* Hamadasuchus. *State (2) occurs in the* Pachycheilosuchus + Pietraroiasuchus *clade,* Iharkutosuchus makadii, Dakosaurus *and* Maledictosuchus riclaensis. *This morphology differs from the procumbency of the first dentary alveolus seen in* Cricosaurus araucanensis*, as they are also partially laterally orientated.* 0. dorsally orientated 1. mainly dorsally orientated, but with a slight anterior orientation 2. strongly anteriorly orientated (procumbent), resulting in the first dentary tooth being directed anteriorly from the mouth, along anteroposterior axis of the skull
310	**Dentary interalveolar spaces, relative size:**

	Young (2014, ch. 160); Young et al. (2012, ch. 131 mod.); Young et al. (2016, ds 2, ch. 189); Ristevski et al. (2018, ds 2, ch. 251); Smith et al. (in review, ds 1, ch. 256); Ősi et al. (2018, ds 1, ch. 283); Foffa et al. (2019, ch. 284). *State (1) occurs in the thalattosuchians* Dakosaurus + Plesiosuchus *sub-clade,* Gracilineustes leedsi *and* Machimosaurus hugii. *It also occurs in* Iharkutosuchus makadii*.* *This character correlates with the maxillary interalveolar space character for the metriorhynchids* Gracilineustes leedsi *and the* Dakosaurus + Plesiosuchus *sub-clade, and for the hylaeochampsid* Iharkutosuchus makadii*, but does not for the teleosauroid* Machimosaurus hugii. 0. interalveolar spaces are variable in size, some are similar in length to the adjacent alveoli, while others are approximately half the length of the immediately adjacent alveoli 1. interalveolar spaces are/almost completely uniformly narrow, being approximately one quarter the length of the immediately adjacent alveoli (or even smaller)
311	**Dentary alveoli, diastema between the first and second alveoli:** *Young et al. (2016, ds 2, ch. 190); Ristevski et al. (2018, ds 2, ch. 252); Smith et al. (in review, ds 1, ch. 257) Ősi et al. (2018, ds 1, ch. 284); Foffa et al. (2019, ch. 285).* *State (1) is a putative apomorphy of* Dakosaurus maximus*.* 0. absent 1. present
312	**Dentary alveoli 1–2, confluence:** *Andrade et al. (2011, ch. 402); Young et al. (2016, ds 2, ch. 191); Ristevski et al. (2018, ds 2, ch. 253); Smith et al. (in review, ds 1, ch. 258); Ősi et al. (2018, ds 1, ch. 285); Foffa et al. (2019, ch. 286).* *State (1) is a putative apomorphy of Goniopholis.* 0. well-separated, usually as much distant from each other as from other dentary teeth 1. alveoli 1–2 confluent, separated by a thin alveolar wall, and clearly apart from neighbouring alveoli
313	**D2 alveoli, size relative to D1 alveoli:** *Hastings et al. (2010, ch. 64 mod.); Young et al. (2016, ds 2, ch. 192); Ristevski et al. (2018, ds 2, ch. 254); Smith et al. (in review, ds 1, ch. 259); Ősi et al. (2018, ds 1, ch. 286); Foffa et al. (2019, ch. 287).* 0. similar in size 1. reduced in size relative to both adjacent alveoli
314	**D3 alveoli, position:** *Hastings et al. (2010, ch. 66 mod.); Ristevski et al. (2018, ds 2, ch. 255); Smith et al. (in review, ds 1, ch. 260); Ősi et al. (2018, ds 1, ch. 287); Foffa et al. (2019, ch. 288).* 0. interalveolar space between D2 and D3 is approximately equal to that between D3 and D4 1. closer to the D4 alveoli
315	**Interalveolar space between the D2 and D3 alveoli relative to that of the D1 and D2 alveoli:** *Hastings et al. (2010, ch. 65 mod.); Young et al. (2016, ds 2, ch. 193); Ristevski et al. (2018, ds 2, ch. 256); Smith et al. (in review, ds 1, ch. 261); Ősi et al. (2018, ds 1, ch. 288); Foffa et al. (2019, ch. 289).* 0. approximately equal in proportion 1. the D2–D3 interalveolar space is longer than the interalveolar space between the D1 and D2
316	**D4 alveolar wall:** *Hastings et al. (2010, ch. 68 mod.); Young et al. (2016, ds 2, ch. 194); Ristevski et al. (2018, ds 2, ch. 257); Smith et al. (in review, ds 1, ch. 262); Ősi et al. (2018, ds 1, ch. 289); Foffa et al. (2019, ch. 290).* 0. level with the adjacent alveoli 1. raised relative to the adjacent alveoli

317	**Dentary alveoli, diastema present between the fourth and fifth alveoli:** *Young (2014, ch. 161); Young et al. (2016, ds 2, ch. 195); Ristevski et al. (2018, ds 2, ch. 258); Smith et al. (in review, ds 1, ch. 263); Ősi et al. (2018, ds 1, ch. 290); Foffa et al. (2019, ch. 291).* *State (1) is a putative apomorphy of Thalattosuchia and* Sarcosuchus. *Within Thalattosuchia: state (0) is a putative apomorphy of the* Dakosaurus + Plesiosuchus *sub-clade.* *Note that while the very small dentary interalveolar spaces are putative apomorphies of* Dakosaurus, Plesiosuchus *and* Gracilineustes leedsi*, the D4–D5 diastema is still present in* Gracilineustes leedsi. 0. absent 1. present
318	**D7 alveoli, size:** *Jouve (2004, ch. 153 mod.); Jouve (2005, ch. 3 mod.); Jouve et al. (2005b, ch. 8 mod.); Jouve et al. (2006, ch. 164 mod.); Jouve et al. (2008, ch. 8 mod.); Hastings et al. (2010, ch. 73 mod.); Young et al. (2016, ds 2, ch. 196 mod.); Ristevski et al. (2018, ds 2, ch. 259); Smith et al. (in review, ds 1, ch. 264); Ősi et al. (2018, ds 1, ch. 291); Foffa et al. (2019, ch. 292).* *State (1) occurs in Dyrosauridae.* 0. comparable in size to the adjacent alveoli 1. reduced in size compared to the adjacent alveoli
319	**D7 alveoli, position:** *Jouve (2004, ch. 153 mod.); Jouve (2005a, ch. 3 mod.); Jouve et al. (2005b, ch. 8 mod.); Jouve et al. (2006, ch. 164 mod.); Jouve et al. (2008, ch. 8 mod.); Hastings et al. (2010, ch. 73 mod.); Young et al. (2016, ds 2, ch. 197 mod.); Ristevski et al. (2018, ds 2, ch. 260); Smith et al. (in review, ds 1, ch. 265); Ősi et al. (2018, ds 1, ch. 292); Foffa et al. (2019, ch. 293).* *State (1) occurs in Dyrosauridae.* 0. comparable in size to the adjacent alveoli 1. close in position to the eighth alveoli
320	**Dentary alveoli, number of alveoli adjacent to the mandibular symphysis:** *Young (2014, ch. 162); Young et al. (2016, ds 2, ch. 198); Ristevski et al. (2018, ds 2, ch. 261); Smith et al. (in review, ds 1, ch. 266); Ősi et al. (2018, ds 1, ch. 293); Foffa et al. (2019, ch. 294).* *Within Thalattosuchia: state (3) is a putative apomorphy of* Dakosaurus. 0. 15 or more 1. 10 to 14 2. 7 to 9 3. 4 to 6 4. fewer than 4
321	**Premaxilla-anterior maxillary tooth crown apicobasal length to basal width ratio:** *Young et al. (2012, ch. 155); Young (2014, ch. 163); Young et al. (2016, ds 2, ch. 199); Ristevski et al. (2018, ds 2, ch. 262); Smith et al. (in review, ds 1, ch. 267); Ősi et al. (2018, ds 1, ch. 294); Foffa et al. (2019, ch. 295).* 0. 3 or greater 1. 2.5 or less
322	**Anterior maxilla, crown size:** *Wilkinson et al. (2008, ch. 56); Young & Andrade (2009, ch. 56); Young et al. (2011, ch. 56); Young et al. (2013a, ch. 133); Young et al. (2012, ch. 156); Young (2014, ch. 164); Young et al. (2016, ds 2, ch. 200); Ristevski et al. (2018, ds 2, ch. 263); Smith et al. (in review, ds 1, ch. 268); Ősi et al. (2018, ds 1, ch. 295); Foffa et al. (2019, ch. 296).* *It is currently unknown if this character correlates with the character quantifying mandibular symphysis depth across Crocodylomorpha. However, in Geosaurinae this is not the case, as shown by Young et al. (2013), the symphysis is deeper in* 'Metriorhynchus' brachyrhynchus *than* Tyrannoneustes lythrodectikos*, but the latter*

	has tooth crowns with a greater apicobasal length. Moreover, the symphyseal depth of Dakosaurus maximus *and* Plesiosuchus manselii *noticeably differ, but both taxa have tooth crowns similar in apicobasal length (Young et al., 2012).* *Anterior maxilla = tooth crowns of the anterior half of the maxillary tooth row.* 0. crowns not enlarged (typically less than 3cm in apicobasal length) 1. moderately enlarged (between 3 and 4 cm in apicobasal length) 2. enlarged (apicobasal length 5 cm or greater)
323	**Anterior maxilla, mediolateral compression/crown cross section:** *Young (2006, ch. 30); Wilkinson et al. (2008, ch. 57); Young & Andrade (2009, ch. 57); Young et al. (2011, ch. 57); Young et al. (2013a, ch. 134 mod.); Young et al. (2012, ch. 157); Young (2014, ch. 165); Young et al. (2016, ds 2, ch. 201); Ristevski et al. (2018, ds 2, ch. 264); Smith et al. (in review, ds 1, ch. 269); Ősi et al. (2018, ds 1, ch. 296); Foffa et al. (2019, ch. 297).* 0. no mediolateral compression 1. weak mediolateral compression (crown midpoint labiolingual width 60–90% distal-medial width) 2. strong mediolateral compression (crown midpoint labiolingual width less than 60% distal-medial width)
324	**Anterior maxilla, constriction at base of crowns:** *Young (2006, ch. 32); Wilkinson et al. (2008, ch. 59); Young & Andrade (2009, ch. 59); Young et al. (2011, ch. 59); Young et al. (2013a, ch. 135); Young et al. (2012, ch. 159); Young (2014, ch. 167); Young et al. (2016, ch. 203); Ristevski et al. (2018, ds 2, ch. 266); Smith et al. (in review, ds 1, ch. 271); Ősi et al. (2018, ds 1, ch. 297); Foffa et al. (2019, ch. 298).* 0. absent 1. present
325	**Maxillary teeth, orientation of the anterior to mid-snout crowns:** *Young & Andrade (2009, ch. 123); Young et al. (2011, ch. 123); Young et al. (2013a, ch. 136); Young et al. (2012, ch. 160); Young (2014, ch. 168); Young et al. (2016, ds 2, ch. 204); Ristevski et al. (2018, ds 2, ch. 267); Smith et al. (in review, ds 1, ch. 272); Ősi et al. (2018, ds 1, ch. 298); Foffa et al. (2019, ch. 299).* 0. not procumbent 1. procumbent
326	**Posterior maxilla, presence of enamel bands:** *Gasparini et al. (2006, ch. 242); Andrade et al. (2011, ch. 418); Young et al. (2011, ch. 167); Young et al. (2013a, ch. 137); Young et al. (2012, ch. 161); Young (2014, ch. 169); Young et al. (2016, ds 2, ch. 205); Ristevski et al. (2018, ds 2, ch. 268); Smith et al. (in review, ds 1, ch. 273); Ősi et al. (2018, ds 1, ch. 299); Foffa et al. (2019, ch. 300).* *'Enamel bands' follow the definition by Brusatte et al. (2007).* *Posterior maxilla = tooth crowns in the posterior half of the maxillary tooth row.* *State (1) occurs in* Dakosaurus *and* Geosaurus*.* 0. absent 1. present
327	**Anterior maxilla, tooth crown tip:** *Young et al. (2011, ch. 183); Young et al. (2013a, ch. 138); Young et al. (2012, ch. 162); Young (2014, ch. 170); Young et al. (2016, ds 2, ch. 206); Ristevski et al. (2018, ds 2, ch. 269); Smith et al. (in review, ds 1, ch. 274); Ősi et al. (2018, ds 1, ch. 300); Foffa et al. (2019, ch. 301).* *State (1) is a putative character of Machimosuarini.* 0. sharp or worn apex 1. blunt and rounded at the tips
328	**Dentary tooth opposite to premaxilla-maxilla contact, isometry:** *based on Clark (1994, ch. 80); Wilkinson et al. (2008, ch. 60); Young & Andrade (2009, ch. 60); Andrade et al. (2011, ch. 408); Young et al. (2011, ch. 60); Young et al. (2013a, ch. 139); Young et al. (2012, ch. 163); Young (2014, ch. 171); Young et*

	al. (2016, ds 2, ch. 207); Ristevski et al. (2018, ds 1, ch. 408); Smith et al. (in review, ds 2, ch. 408); Ősi et al. (2018, ds 1, ch. 301); Foffa et al. (2019, ch. 302). Alveolar size may be used as a reasonable proxy for crown size, when teeth are not preserved. 0. subequal to other neighbouring teeth 1. tooth is at least evidently enlarged, anisometric relative to other neighbouring teeth
329	**Dentary tooth opposite to premaxilla-maxilla contact, length:** *Clark (1994, ch. 80); Sereno et al. (2003, ch. 54); Andrade & Bertini (2008a, ch. 142); Andrade et al. (2011, ch. 409); Ristevski et al. (2018, ds 1, ch. 409); Smith et al. (in review, ds 2, ch. 409); Ősi et al. (2018, ds 1, ch. 302); Foffa et al. (2019, ch. 303).* *Alveolar size may be used as a reasonable proxy for crown size, when teeth are not preserved.* 0. small to medium sized, but length is no more than twice the length of other neighbouring teeth 1. hypertrophied, at least twice longer than neighbouring teeth
330	**Dentary tooth opposite to premaxillary-maxillary suture, occlusion:** *Norell (1988, ch. 29); Brochu (1999, ch. 77 mod.); Andrade et al. (2011, ch. 410); Ristevski et al. (2018, ds 1, ch. 410); Smith et al. (in review, ds 2, ch. 410); Ősi et al. (2018, ds 1, ch. 303); Foffa et al. (2019, ch. 304).* *The series cannot be ordered, as a transition between states (0) - (2) is possible without intermediate steps.* 0. occludes either in notch at premaxilla and maxilla early in ontogeny, or lateral to premaxilla-maxilla suture, when the notch is absent or poorly defined 1. occludes in a pit between premaxilla and maxilla; no notch early in ontogeny 2. occludes medial to premaxilla-maxilla suture, but not in a pit or a notch
331	**Dentary tooth occluding against premaxillary-maxillary suture:** *based on Norell (1988, ch. 29) and Clark (1994, ch. 80) and Brochu (1999, ch. 77); Andrade et al. (2011, ch. 411); Ristevski et al. (2018, ds 1, ch. 411); Smith et al. (in review, ds 2, ch. 411); Ősi et al. (2018, ds 1, ch. 304); Foffa et al. (2019, ch. 305).* *The tooth occluding to the premaxillomaxillary suture is usually seen as the fourth dentary tooth, but in Crocodylomorpha this may be another tooth due to the loss of anterior teeth or other morphological adaptation. The tooth is not necessarily enlarged, and may be isometric to neighbouring teeth.* *State (0) is putative apomorphy of* Mahajangasuchus, *Sphagesauridae, and Teleosauroidea.* *State (2) is putative apomorphy of* Sarcosuchus*.* *Note that in teleosauroids, the D3 tooth contacts the premaxilla-maxilla suture, not the D4 tooth, due to the orientation of the D3-D4 couplet.* 0. third, or anterior 1. fourth 2. fifth, or posterior
332	**Dentition, relation between tooth rows on both sides of the skull:** *Novas et al. (2009); Andrade et al. (2011, ch. 367); Ristevski et al. (2018, ds 1, ch. 367); Smith et al. (in review, ds 2, ch. 367); Ősi et al. (2018, ds 1, ch. 305); Foffa et al. (2019, ch. 306).* *State (1) is putative autapomorphy of* Yacarerani*, where maxillary tooth rows converge at mid-palate, the same occurring with the dentition in the mandible. As a consequence, anterior teeth (pairs 1-4) both in the upper and lower dentition constitute functionally distinct sets, one anterior and one posterior. Teeth at the posterior set (mid-dentition) are located close to the median line of the skull, with first tooth at least almost in contact with its complementary tooth.* 0. forming one continuous set of teeth, both in the cranium and mandible 1. forming two distinct sets, tooth rows at posterior set convergent rostrally and almost in touch each other, at mid-palate and mandible
333	**Posterior maxillary teeth, transverse section:**

	Buckley et al. (2000, ch. 116 mod.); Ortega et al. (2000, ch. 104 mod.); Andrade & Bertini (2008, ch. 135); Andrade et al. (2011, ch. 368); Ristevski et al. (2018, ds 1, ch. 368); Smith et al. (in review, ds 2, ch. 368); Ősi et al. (2018, ds 1, ch. 306); Foffa et al. (2019, ch. 307). 0. evident lateral compression affecting both edges of the crown, making both edges evident regardless of the presence/absence of carinae/keel 1. transverse section circular to subcircular, without significant lateral compression 2. transverse section 'teardrop-like' (= triangular), with asymmetric lateral compression occurring on the distal margin only
334	**Mid to posterior mandibular teeth, transverse section:** *Buckley et al. (2000, ch. 116 mod.); Ortega et al. (2000, ch. 104 mod.); as in Andrade & Bertini (2008, ch. 146); Andrade et al. (2011, ch. 369); Ristevski et al. (2018, ds 1, ch. 369); Smith et al. (in review, ds 2, ch. 369); Ősi et al. (2018, ds 1, ch. 307); Foffa et al. (2019, ch. 308).* 0. evident lateral compression affecting the entire crown, making evident both mesial and distal edges, regardless of the presence/absence of carinae/keel 1. transverse section circular to subcircular, without significant lateral compression 2. transverse section 'teardrop-like' (= triangular), with asymmetric lateral compression occurring on the mesial margin only
335	**Dentition, presence of apicobasal facets on the labial surface:** *Young & Andrade (2009, ch. 130); Andrade et al. (2011, ch. 370); Young et al. (2011, ch. 130); Young et al. (2013a, ch. 140); Young et al. (2012, ch. 164); Young (2014, ch. 172); Young et al. (2016, ds 2, ch. 208); Ristevski et al. (2018, ds 2, ch. 271); Smith et al. (in review, ds 1, ch. 276); Ősi et al. (2018, ds 1, ch. 308); Foffa et al. (2019, ch. 309).* *State (1) is a putative apomorphy of* Geosaurus giganteus, G. grandis + Ieldraan melkshamensis. 0. absent, either lacking facets, or facetted into 4–5 indistinct planes 1. present, most crowns have the labial surface distinctly facetted into three planes (one large medial one, and two smaller planes either side)
336	**Dentition, presence of laminar teeth:** *Andrade et al. (2011, ch. 371); Young et al. (2011, ch. 170); Young et al. (2013a, ch. 141); Young et al. (2012, ch. 165); Young (2014, ch. 173); Young et al. (2016, ds 2, ch. 209); Ristevski et al. (2018, ds 2, ch. 272); Smith et al. (in review, ds 1, ch. 277); Ősi et al. (2018, ds 1, ch. 309); Foffa et al. (2019, ch. 310).* *State (1) is a putative apomorphy of Geosaurina (*Geosaurus + Ieldraan*).* *For practical purposes, 'laminar tooth' are here considered as teeth with cross-section highly elliptical at the base of crown, with mesial-distal axis approximately twice the labial-lingual axis, or greater.* 0. absent 1. present, laminar teeth dominate dentition
337	**Dentition, presence of spatulated teeth:** *Buckley et al. (2000, ch. 116 mod.); Andrade et al. (2011, ch. 372); Ristevski et al. (2018, ds 1, ch. 372); Smith et al. (in review, ds 2, ch. 372); Ősi et al. (2018, ds 1, ch. 310); Foffa et al. (2019, ch. 311).* *The spatulated morphology refers to the morphology of the crown, not simply its compression, number of cusps or presence of cingula. Therefore, it is considered as a different character, and treated separately. However, all spatulated teeth are considered as laterally compressed.* *State (1) occurs in* Candidodon, Malawisuchus *and* Uruguaysuchus*.* 0. absent 1. present

338	**Dentition, presence of tribodont teeth in both the posterior maxillae and dentaries:** *Ristevski et al. (2018, ds 2, ch. 274); Smith et al. (in review, ds 1, ch. 279); Ősi et al. (2018, ds 1, ch. 311); Foffa et al. (2019, ch. 312).* *State (1) occurs in Bernissartiidae and in some alligatoroids*. *For practical purposes, 'tribodont teeth' are here considered as teeth that are 'low crowned', bulbous, mesiodistally compressed, single cusped, and lack carinae.* 0. absent 1. present
339	**Dentition, presence of carinae on apical third: (NEW)** *State (1) occurs in* Bathysuchus megarhinus and Sericodon jugleri. *NB: this may be due to variation, or a phylogenetic signal.* 0. present 1. absent
340	**Dentition, presence of enamel ridges on apical third: (NEW)** *State (0) occurs in* Sericodon jugleri*, an unnumbered French MNHN.F teleosauroid and unnumbered* Teleosaurus *Holzmaden tooth.* *NB: this may be due to variation, or a phylogenetic signal.* 0. absent 1. present
341	**Mid to posterior dentition, presence of pebbled ornamentation on tooth crown surface:** *Andrade et al. (2011, ch. 374); Ristevski et al. (2018, ds 1, ch. 374); Smith et al. (in review, ds 2, ch. 374); Ősi et al. (2018, ds 1, ch. 312); Foffa et al. (2019, ch. 313).* *State (1) is putative apomorphy of Sphagesauridae.* 0. absent 1. present, enamel ornamented with a pebbled pattern
342	**Mid to posterior dentition, presence of accessory ridges on labial-lingual surfaces of crown:** *Andrade et al. (2011, ch. 376); Ristevski et al. (2018, ds 1, ch. 376); Smith et al. (in review, ds 2, ch. 376); Ősi et al. (2018, ds 1, ch. 313); Foffa et al. (2019, ch. 314).* *The ridges present in* Notosuchus *and sphagesaurids do involve enamel and dentine, therefore should not be considered as superficial ornamentation.* *State (1) occurs in* Notosuchus *and in derived sphagesaurids (i.e. not* Adamantinasuchus *and* Yacareni*).* 0. absent 1. present, apicobasal, evident and well-spaced, formed by enamel and dentine
343	**Mid to posterior dentition, number of cusps per tooth:** *Gomani (1997, ch. 46 mod.); Buckley et al. (2000, ch. 113 mod.); Pol (2003, ch. 162 mod.); Turner & Buckley (2008, ch. 188 mod.); Andrade et al. (2011, ch. 377); Ristevski et al. (2018, ds 1, ch. 377); Smith et al. (in review, ds 2, ch. 377); Ősi et al. (2018, ds 1, ch. 314); Foffa et al. (2019, ch. 315).* *This character was modified by Andrade et al. (2011), and here only the main crown is evaluated, not the presence of accessory cusps in cingula. This is considered as a separate character. However, note that states (2) and (3) sample teeth where primary and secondary rows of cusps are present, while in states (0) and (1) there is only one row.* *State (1) occurs in* Malawisuchus*.* *State (2) occurs in* Iharkutosuchus*.* *State (3) occurs in* Edentosuchus *and* Kayentasuchus, *not sampled in this analysis.* 0. each crown has single apical cusp, regardless of presence of accessory cusps in cingula 1. each crown has one main cusp aligned with smaller cusps, arranged in a single row 2. several cusps, unequal in size, arranged in more than one row 3. multiple small cusps, subequal in size, along edges of occlusal surface
344	**Tooth wear, macroscopic wear along the carinae/mesiodistal margins:**

	Young et al. (2016, ds 2, ch. 211); Ristevski et al. (2018, ds 2, ch. 275); Smith et al. (in review, ds 1, ch. 280); Ősi et al. (2018, ds 1, ch. 315); Foffa et al. (2019, ch. 316). *State (1) is a putative apomorphy of* Dakosaurus + *Mr Leeds dakosaur.* 0. absent 1. present
345	**Anterior–middle dentition, tooth crown curvature:** *Young (2006, ch. 31); Wilkinson et al. (2008, ch. 58); Young & Andrade (2009, ch. 58); Young et al. (2011, ch. 58); Young et al. (2013a, ch. 142); Young et al. (2012, ch. 166); Young (2014, ch. 174); Young et al. (2016, ds 2, ch. 212); Ristevski et al. (2018, ds 2, ch. 276); Smith et al. (in review, ds 1, ch. 281); Ősi et al. (2018, ds 1, ch. 316); Foffa et al. (2019, ch. 317).* *State (0) is a putative apomorphy of Machimosuarini.* *NB that the curvature in* Sericodon jugleri *is continusously present in the apical third of the tooth.* 0. none, crown apical/subapical (between 91 – 89 degrees) 1. weakly recurved (between 88 – 82 degrees) 2. strongly recurved (less than 80 degrees)
346	**Carinae, presence of keel at the edge of tooth crown:** *Young (2006, ch. 29 mod., part); Wilkinson et al. (2008, ch. 55 mod., part); Young & Andrade (2009, ch. 55 mod., part); Andrade et al. (2011, ch. 378); Young et al. (2011, ch. 55 mod., part); Young et al. (2013a, ch. 143 mod., part); Young et al. (2012, ch. 167 mod.); Young (2014, ch. 175); Young et al. (2016, ds 2, ch. 213 mod.); Ristevski et al. (2018, ds 2, ch. 277); Smith et al. (in review, ds 1, ch. 282); Ősi et al. (2018, ds 1, ch. 317); Foffa et al. (2019, ch. 318).* *Currently, no data suggests differential presence of keels in antero-posterior or upper-lower dentition, therefore a single character is used. Mesial-distal keels may occur independently from denticles in the mesial and distal carinae; denticulated carinae may or may not have keel on denticles.* 0. absent (i.e. lacks keeled carinae) 1. present (i.e. carinated sensu stricto, created by a smooth keel [raised ridge] on the crown edges, typically on the mesial and distal margins)
347	**Carinae, presence of 'carinal flanges': (*)** *Ristevski et al. (2018, ds 2, ch. 278); Smith et al. (in review, ds 1, ch. 283); Ősi et al. (2018, ds 1, ch. 318); Foffa et al. (2019, ch. 319).* *State (1) occurs in* Plesiosuchus*,* Suchodus *and Mr Leeds Dakosaur*. *State (2) occurs in* Dakosaurus. *This character is not applicable for taxa that lack carinae on all tooth crowns.* 0. absent - the external surfaces of the tooth crowns are still convex/straight when they approach the carinae 1. poorly-developed - the external surface of the tooth crown becomes concave immediately adjacent to the carinae. However, they are unequally expressed on the labial and lingual surfaces, and are rarely expressed along the entire carina 2. well-developed - the external surface of the tooth crown becomes concave immediately adjacent to the carinae. They are present on both the labial and lingual surfaces, being most noticeably developed at the mid-crown and apex
348	**Carinae, height of the keel in the apical region:** *Ristevski et al. (2018, ds 2, ch. 279); Smith et al. (in review, ds 1, ch. 284); Ősi et al. (2018, ds 1, ch. 319); Foffa et al. (2019, ch. 320).* *State (1) occurs in* Torvoneustes. 0. keel is either absent, or not greatly enlarged 1. keel is greatly enlarged in height
349	**Carinae, presence of false ziphodont serrations at crown edges: (*)** *Young et al. (2011, ch. 172 part); Young et al. (2013a, ch. 144 part); Young et al. (2012, ch. 168 part); Young (2014, ch. 176 part); Young et al. (2016, ds 2, ch. 214 part); Ristevski et al. (2018, ds 2, ch. 280); Smith et al. (in review, ds 1, ch. 285); Ősi et al. (2018, ds 1, ch. 320); Foffa et al. (2019, ch. 321).*

	This character is not applicable for taxa that lack carinae on all tooth crowns. *False ziphodonty (= conspicuous superficial enamel ornamentation contacting the keel) herein follows the definition described in Prasad & de Lapparent de Broin (2002).* *State (1) occurs in* Theriosuchus pusillus*.* *State (2) occurs in* Goniopholis, Anteophthalmosuchus, Torvoneustes*, and Machimosaurini.* 0. absent across the dentition 1. present, but restricted to the tooth crowns in the posterior end of the tooth row 2. present across the dentition
350	**Carinae, presence and development of true denticles at crown edges: (*)** *Young (2006, ch. 29 part); Wilkinson et al. (2008, ch. 55 part); Young & Andrade (2009, ch. 53 part); Young et al. (2011, ch. 53 part); Young et al. (2012, ch. 169); Young (2014, ch. 177); Young et al. (2016, ds 2, ch. 215); Ristevski et al. (2018, ds 2, ch. 281); Smith et al. (in review, ds 1, ch. 286); Ősi et al. (2018, ds 1, ch. 321); Foffa et al. (2019, ch. 322).* *In Thalattosuchia, basal geosaurines are scored as state (1).* *Derived genera within Geosaurini are scored as state (2).* *This character is not applicable for taxa that lack carinae on all tooth crowns.* *True ziphodonty herein follows the definition described in Prasad & de Lapparent de Broin (2002).* 0. absent 1. incipient denticles that are poorly defined (hard to discern, in some cases even under Scanning Electron Microscopy). Typically, they either alter the height of the carinal keel very little or not at all (definition described in Young *et al*., 2013) 2. well-defined denticles (can be discerned with or without optical aids)
351	**Carinae (mid-posterior dentition), presence and morphology of denticles at crown edges:** *Buckley et al. (2000, ch. 104 mod.); Sereno et al. (2003, ch. 53 mod.); Andrade & Bertini (2008a, ch. 132 rev.); Andrade et al. (2011, ch. 379 mod. – character states re-ordered); Young et al. (2011, ch. 172 mod.); Young et al. (2013a, ch. 145 mod.); Young et al. (2012, ch. 170 mod.); Young (2014, ch. 178 mod.); Young et al. (2016, ds 2. ch. 216 mod. – new character state added); Ristevski et al. (2018, ds 2, ch. 282); Smith et al. (in review, ds 1, ch. 287); Ősi et al. (2018, ds 1, ch. 322); Foffa et al. (2019, ch. 323).* *State (1) is putative apomorphy of Notosuchidae + Sphagesauridae.* *In Thalattosuchia, basal geosaurines score as state (2).* *Derived genera within Geosaurini score as state (3).* *Note that this character and the character describing the presence of true denticles appear to correlate. However, the two morphologies are not the same, and it is possible that taxa can score differently for these two characters (i.e., the ziphomorphy condition – see Andrade & Bertini, 2008a).* *Moreover, in Metriorhynchidae the development of the denticles, and whether they form a contiguous row along the carina is highly variable. Some taxa have contiguous and well-defined denticles (e.g.* Dakosaurus*,* Plesiosuchus*,* Geosaurus*) while some taxa have contiguous but incipient denticles (*Torvoneustes*), others non-contiguous incipient denticles (*Tyrannoneustes*,* 'M.' brachyrhynchus*).* 0. carinae and/or denticles are absent (non-ziphodont), or homogenous carina where serrations may appear as the result of superficial enamel ornamentation (false ziphodont) 1. heterogeneous carina, tubercle-like true denticles that do not form a series (ziphomorph) 2. heterogeneous carina, cuneiform or ripple-like true denticles form short rows of 2–10 denticles and do not proceed contiguously along the entire carina (incipient ziphodont) 3. homogeneous carina, cuneiform or ripple-like true denticles form a contiguous, or near contiguous, series along the entire carina (ziphodont)

352	**Carinae, true denticle shape when observed in lingual or labial view: (*)** *Young et al. (2012, ch. 171); Young (2014, ch. 179); Young et al. (2016, ds 2, ch. 217); Ristevski et al. (2018, ds 2, ch. 283); Smith et al. (in review, ds 1, ch. 288); Ősi et al. (2018, ds 1, ch. 324);* *In Thalattosuchia, Plesiosuchina (*Plesiosuchus *and* Suchodus*)* are *scored as state (0).* *This character is not applicable for taxa that lack carinae on all tooth crowns, and for those that lack denticles.* 0. "chisel"-shaped or rectangular 1. rounded
353	**Carinae, denticle distribution across the dentition:** *Young et al. (2012, ch. 172); Young (2014, ch. 180); Young et al. (2016, ds 2, ch. 218); Ristevski et al. (2018, ds 2, ch. 284); Smith et al. (in review, ds 1, ch. 289); Ősi et al. (2018, ds 1, ch. 324); Foffa et al. (2019, ch. 325).* *In Thalattosuchia, state (2) occurs in* Dakosaurus*.* *At present no taxon is known to combine the microziphodont and macroziphodont conditions. However, it is entirely possible that such a taxon could occur. As such, state (3) was created.* *In Thalattosuchia,* Dakosaurus *scores as (2), while* 'Metriorhynchus' brachyrhynchus, Tyrannoneustes lythrodectikos*,* Torvoneustes*,* Geosaurus *and* Plesiosuchus *score as (1).* *Note that this character appears to correlate with the characters describing the incipient/well-developed denticles) and homogeneous/heterogenous carinae. However, these morphologies are not the same, and it is possible that taxa can score differently for these three characters.* *In Metriorhynchidae the development of the macroscopic denticles is a putative apomorphy of* Dakosaurus*, giving this genus macroscopic, well-defined contiguous denticles. In contrast,* Plesiosuchus *and* Geosaurus *have microscopic, well-defined contiguous denticles;* Torvoneustes *has microscopic, incipient contiguous denticles; while* Tyrannoneustes *and* 'M.' brachyrhynchus *have microscopic, incipient, non-contiguous denticles.* *Thus, these three characters are describing a different aspect of denticle development and arrangement.* 0. all or most teeth lack denticles 1. all teeth are microziphodont (*sensu* Andrade *et al*., 2010) 2. all teeth are macroziphodont (*sensu* Andrade *et al*., 2010) 3. teeth show variation in denticle size (with both microziphodonty and macroziphodonty)
354	**Carinae (maxillae), distribution of denticles at crown edges:** *based on Price (1950) and Pol (2003); Andrade & Bertini (2008a, ch. 132 mod.); Andrade et al. (2011, ch. 380); Ristevski et al. (2018, ds 1, ch. 380); Smith et al. (in review, ds 2, ch. 380); Ősi et al. (2018, ds 1, ch. 325); Foffa et al. (2019, ch. 326).* *This character samples presence of true denticles only, not all serrated carinae or ziphomorph denticles.* *State (1) is putative apomorphy of Notosuchidae + Sphagesauridae (but note that* Adamantinasuchus *and* Mariliasuchus *do not share the character).* 0. mesial and distal crown edges with the same morphology, either with or without true denticles 1. mesial carina absent and distal carina present
355	**Carinae (mid-posterior mandible), distribution of denticles at crown edges:** *Andrade & Bertini (2008a, ch. 132 mod.); Andrade et al. (2011, ch. 381); Ristevski et al. (2018, ds 1, ch. 381); Smith et al. (in review, ds 2, ch. 381); Ősi et al. (2018, ds 1, ch. 326); Foffa et al. (2019, ch. 327).* *State (1) is putative apomorphy of Sphagesaurus, but unknown in* Armadillosuchus*.* 0. mesial and distal crown edges with the same morphology, either with or without true denticles

	1. mesial carina present and distal carina absent, with mid-posterior teeth occluding as opposing blades
356	**Occlusion, relation between maxillary and dentary series:** *Young et al. (2011, ch. 173); Young et al. (2013a, ch. 146); Young et al. (2012, ch. 173); Young (2014, ch. 181); Young et al. (2016, ds 2, ch. 219); Ristevski et al. (2018, ds 2, ch. 285); Smith et al. (in review, ds 1, ch. 290); Ősi et al. (2018, ds 1, ch. 327); Foffa et al. (2019, ch. 328).* 0. in-line or interlocked 1. maxillary dentition overbites dentary dentition
357	**Morphology of enamel surface ornamentation, apicobasal ridges:** *Young et al. (2011, ch. 174); Young et al. (2013a, ch. 147); Young et al. (2012, ch. 174 mod.); Young (2014, ch. 182 mod.); Young et al. (2016, ds 2, ch. 220 mod.); Ristevski et al. (2018, ds 2, ch. 286 mod.); Smith et al. (in review, ds 1, ch. 291 mod.); Ősi et al. (2018, ds 1, ch. 328); Foffa et al. (2019, ch. 329).* *In Thalattosuchia,* Geosaurus*,* Dakosaurus, Rhacheosaurus *and* Cricosaurus *score as state (0).* *State (1) occurs in* Ieldraan melkshamensis*.* *State (2) occurs in* Tyrannoneustes lythrodectikos*.* *State (3) occurs in Mr Leeds dakosaur,* Suchodus durobrivensis, Plesiosuchus manselii*.* *State (4) is the standard, ridged crocodylomorph morphotype.* *State (5) occurs in Mr Passmore's specimen.* 0. enamel ornamentation absent macroscopically (although under SEM microscopic ripples may be present) 1. enamel ornamentation present macroscopically, but largely looks like an enlarged version of the 'rippled' morphology seen under the SEM in 'smooth specimens'. There may also be the occasional poorly defined apicobasal ridge 2. enamel ornamentation largely inconspicuous, being composed of short, well-spaced, well-defined apicobasally aligned ridges on at least the basal half of the crown 3. enamel ornamentation composed of numerous apicobasally aligned ridges that are of low-relief (can only be properly viewed with visual aids), set close to each other, but become shorter and well-spaced towards the carinae 4. enamel ornamentation composed of well-defined apicobasally aligned ridges that are conspicuous and are elongate; being continuous, or having long discontinuous ridges 5. noticeable disparity between the labial and lingual surfaces: lingual surface changes from the standard apicobasal ridge morphology basally, to having shorter ridges which create almost reticulating pattern in the mid-crown region on the lingual surface; on the labial surface, basally the crown is largely smooth, and nearer the mid-crown and up towards the apex the crown is ornamented with numerous short ridges that similarly can make a reticulating pattern
358	**Morphology of apical enamel surface ornamentation, macroscopic anastomosed pattern:** *Young et al. (2012, ch. 175); Young (2014, ch. 183); Young et al. (2016, ds 2, ch. 221); Ristevski et al. (2018, ds 2, ch. 287); Smith et al. (in review, ds 1, ch. 292); Ősi et al. (2018, ds 1, ch. 329); Foffa et al. (2019, ch. 330).* *State (1) occurs in Machimosaurini* (e*.g.* Machimosaurus, Yvridiosuchus*,* Lemmysuchus), Torvoneustes, *and Goniopholididae (e.g.* Anteophthalmosuchus *and* Goniopholis*).* 0. absent 1. present and strongly developed, but only in the apical region of the crown
359	**Maxillary teeth, occurrence of bilateral paramesial rotation: (ORDERED)** *Pol (2003, ch. 137 mod.); Andrade & Bertini (2008a, ch. 133); Andrade et al. (2011, ch. 414); Ristevski et al. (2018, ds 1, ch. 414); Smith et al. (in review, ds 2, ch. 414); Ősi et al. (2018, ds 1, ch. 330); Foffa et al. (2019, ch. 331).* *State (1) occurs in* Mariliasuchus *and* Notosuchus*.*

	State (2) is a putative apomorphy of Sphagesauridae. 0. absent 1. bilateral paramesial rotation up to 30 degrees from the original plane 2. bilateral paramesial rotation clearly over 30 degrees from the original plane
360	**Middle and posterior mandibular teeth, occurrence of bilateral paramesial rotation:** *Andrade & Bertini (2008a, ch. 144); Andrade et al. (2011, ch. 415); Ristevski et al. (2018, ds 1, ch. 415); Smith et al. (in review, ds 2, ch. 415); Ősi et al. (2018, ds 1, ch. 331); Foffa et al. (2019, ch. 332).* *State (2) is a putative apomorphy of Sphagesauridae.* 0. not oblique or slightly altered 1. oblique (more than 30 degrees)
361	**Middle and posterior teeth, presence of cingula with accessory cusps:** *Andrade & Bertini (2008a, ch. 149 mod.); Andrade et al. (2011, ch. 417); Ristevski et al. (2018, ds 1, ch. 417); Smith et al. (in review, ds 2, ch. 417); Ősi et al. (2018, ds 1, ch. 332); Foffa et al. (2019, ch. 333).* *State (1) occurs in* Candidodon *and* Malawisuchus*.* 0. absent 1. present, cingulum bearing a series small of cusps, set labial/lingual to the main body of crown
362	**Morphology of enamel surface ornamentation, 'pseudodenticles':** *Ristevski et al. (2018, ds 2, ch. 288); Smith et al. (in review, ds 1, ch. 293); Ősi et al. (2018, ds 1, ch. 333); Foffa et al. (2019, ch. 334).* *State (1) occurs in* Machimosaurus hugii *and* M. rex*. The 'pseudodenticles' are denticle-like structures that occur on the enamel ridges, but not on the carinae.* 0. absent 1. present

Axial post-cranial skeleton (Ch. 363 – 401; 7.128% of characters)

[*Vertebrae (= cervicale, thoracicae, lumbales, sacrales and caudal), costae (= cervicales, thoracicae, sacrales and arcus hæmales)*]

#	Description
363	**Atlas, hypocentrum length:** *Young & Andrade (2009, ch. 122); Young et al. (2011, ch. 122); Young et al. (2013a, ch. 148); Young et al. (2012, ch. 176); Young (2014, ch. 184); Young et al. (2016, ds 2, ch. 222); Ristevski et al. (2018, ds 2, ch. 289); Smith et al. (in review, ds 1, ch. 294); Ősi et al. (2018, ds 1, ch. 334); Foffa et al. (2019, ch. 335).* 0. long: greater than 15% of odontoid process length 1. short: subequal to odontoid process length (± 5%)
364	**Axis, neural arch diapophysis:** *Young & Andrade (2009, ch. 104); Young et al. (2011, ch. 104); Young et al. (2013a, ch. 149); Young et al. (2012, ch. 177); Young (2014, ch. 185); Young et al. (2016, ds 2, ch. 223); Ristevski et al. (2018, ds 2, ch. 290); Smith et al. (in review, ds 1, ch. 295); Ősi et al. (2018, ds 1, ch. 335); Foffa et al. (2019, ch. 336).* 0. absent 1. present
365	**Presacral vertebrae number:** *Young & Andrade (2009, ch. 156); Young et al. (2011, ch. 156); Young et al. (2013a, ch. 150); Young et al. (2012, ch. 178); Young (2014, ch. 186); Young et al. (2016, ds 2, ch. 224); Ristevski et al. (2018, ds 2, ch. 291); Smith et al. (in review, ds 1, ch. 296); Ősi et al. (2018, ds 1, ch. 336); Foffa et al. (2019, ch. 337).* 0. 24 1. 25
366	**Number of cervico-dorsal vertebrae where the parapophyses are borne on the centrum ('cervical vertebrae'), including the atlas-axis:**

	Young (2006, ch. 35 mod.); Wilkinson et al. (2008, ch. 63 mod.); Young & Andrade (2009, ch. 63 mod.); Young et al. (2011, ch. 63 mod.); Young et al. (2013a, ch. 151); Young et al. (2012, ch. 179); Young (2014, ch. 187); Young et al. (2016, ds 2, ch. 225); Ristevski et al. (2018, ds 2, ch. 292); Smith et al. (in review, ds 1, ch. 297); Ősi et al. (2018, ds 1, ch. 337); Foffa et al. (2019, ch. 338). 0. 9 or 10 1. 8 2. 7
367	**Cervical vertebrae, hypapophyses:** *Ristevski et al. (2018, ds 2, ch. 293 mod.); Smith et al. (in review, ds 1, ch. 298 modified); Ősi et al. (2018, ds 1, ch. 338); Foffa et al. (2019, ch. 339).* *This character scores the presence of distinct hypapophyses on the ventral surface of the cervical centra.* *State (1) is a putative apomorphy of Thalattosuchia.* 0. present 1. reduced, distinct ventral processes are absent, but a reduced anteroposterior keel is still present
368	**Cervical vertebrae, shape:** *Clark (1994, ch. 92 mod.); Young & Andrade (2009, ch. 145 mod.); Young et al. (2011, ch. 145 mod.); Young et al. (2013a, ch. 152 mod.); Young et al. (2012, ch. 180 mod.); Young (2014, ch. 188 mod.); Young et al. (2016, ds 2, ch. 226); Ristevski et al. (2018, ds 2, ch. 294); Smith et al. (in review, ds 1, ch. 299); Ősi et al. (2018, ds 1, ch. 339); Foffa et al. (2019, ch. 340).* *Designed to test the homology of repeated procoely evolution in Crocodylomorpha.* *State (2) is occurs in Eusuchia.* 0. amphicoelous or amphyplatian 1. weakly procoelous (i.e. the *Isisfordia* and *Junggarsuchus* morphotype – posterior condyle is poorly developed, with the rim of the posterior face of the centrum still distinct from the convexity of the condyle) 2. strongly procoelous (i.e. the eusuchian morphotype – well-developed posterior condyle, which is formed by the entire posterior face of the centrum)
369	**Posterior cervical vertebrae, centrum length vs centrum width:** *Young (2006, ch. 34); Wilkinson et al. (2008, ch. 62); Young & Andrade (2009, ch. 62); Young et al. (2011, ch. 62); Young et al. (2013a, ch. 153); Young et al. (2012, ch. 181); Young (2014, ch. 189); Young et al. (2016, ds 2, ch. 227); Ristevski et al. (2018, ds 2, ch. 295); Smith et al. (in review, ds 1, ch. 300); Ősi et al. (2018, ds 1, ch. 340); Foffa et al. (2019, ch. 341).* *State (1) occurs in Geosaurinae.* *State (2) is a putative apomorphy of Metriorhynchidae.* 0. long (centrum length more than 1.5 times the centrum width) 1. moderate (centrum length to width subequal, ± 5%) 2. short (centrum length less than 95% of the centrum width)
370	**Middle cervical vertebrae, neural spine height relative to centrum height:** *Young et al. (2012, ch. 182); Young (2014, ch. 190); Young et al. (2016, ds 2, ch. 228); Ristevski et al. (2018, ds 2, ch. 296); Smith et al. (in review, ds 1, ch. 301); Ősi et al. (2018, ds 1, ch. 341); Foffa et al. (2019, ch. 342).* *Currently, there is not the information needed to score for most crocodylomorphs. Within Thalattosuchia* Neosteneosaurus edwardsi *is (0),* Charitomenosuchus leedsi *is (1), and metriorhynchids are state (2).* 0. neural spine height is greater than centrum height 1. neural spine and centrum heights are approximately equal 2. neural spine height is less than centrum height
371	**Number of cervico-dorsal vertebrae where the parapophyses are borne partially, or solely, on the neural arch ('thoracic vertebrae'):** *Young et al. (2011, ch. 175); Young et al. (2013a, ch. 154); Young et al. (2012, ch. 183); Young (2014, ch. 191); Young et al. (2016, ds 2, ch. 229); Ristevski et al.*

	(2018, ds 2. ch. 297); Smith et al. (in review, ds 1, ch. 302); Ősi et al. (2018, ds 1, ch. 342); Foffa et al. (2019, ch. 343). *This character, (along with the character categorising lumbar vertebrae) was formulated to help understand the regionalisation of the presacral column. Currently, there is not the information needed to score for most crocodylomorphs.* 0. 12 1. 13 2. 14 3. 15
372	**Number of cervico-dorsal vertebrae posterior to the "thoracic vertebrae" and anterior to the sacral vertebrae where the parapophyses are no longer borne on the neural arch ('lumbar vertebrae'):** *Young et al. (2011, ch. 176); Young et al. (2013a, ch. 155); Young et al. (2012, ch. 184); Young (2014, ch. 192); Young et al. (2016, ds 2, ch. 230); Ristevski et al. (2018, ds 2, ch. 298); Smith et al. (in review, ds 1, ch. 303); Ősi et al. (2018, ds 1, ch. 343); Foffa et al. (2019, ch. 344).* *This character, (along with the character categorising thoracic vertebrae) was formulated to help understand the regionalisation of the presacral column. Currently, there is not the needed information to score for most crocodylomorphs.* 0. 2 1. 3 2. 4
373	**Thoracic and lumbar vertebrae, shape:** *Clark (1994, ch. 93 mod.); Young & Andrade (2009, ch. 146 mod.); Young et al. (2011, ch. 146 mod.); Young et al. (2013a, ch. 156 mod.); Young et al. (2012, ch. 185 mod.); Young (2014, ch. 193 mod.); Young et al. (2016, ds 2, ch. 231); Ristevski et al. (2018, ds 2, ch. 299); Smith et al. (in review, ds 1, ch. 304); Ősi et al. (2018, ds 1, ch. 344); Foffa et al. (2019, ch. 345).* *State (2) is a putative apomorphy of Eusuchia.* 0. amphicoelous or amphyplatian 1. weakly procoelous (i.e. the *Isisfordia* and *Junggarsuchus* morphotype – posterior condyle is poorly developed, with the rim of the posterior face of the centrum still distinct from the convexity of the condyle) 2. strongly procoelous (i.e. the eusuchian morphotype – well-developed posterior condyle, which is formed by the entire posterior face of the centrum)
374	**Thoracic vertebrae, shallow fossa on the anterior margin of the diapophysis immediately lateral to the parapophysis:** *Young & Andrade (2009, ch. 165); Young et al. (2011, ch. 165); Young et al. (2013a, ch. 157); Young et al. (2012, ch. 186 mod.); Young (2014, ch. 194); Young et al. (2016, ds 2, ch. 232); Ristevski et al. (2018, ds 2, ch. 300); Smith et al. (in review, ds 1, ch. 305); Ősi et al. (2018, ds 1, ch. 345); Foffa et al. (2019, ch. 346).* *State (1) is a putative apomorphy of Metriorhynchidae, best observed in thoracic vertebrae mid-to-late in the series.* 0. present 1. absent
375	**Thoracic vertebrae, orientation of parapophysis:** *Young & Andrade (2009, ch. 166); Young et al. (2011, ch. 166); Young et al. (2013a, ch. 158); Young et al. (2012, ch. 187); Young (2014, ch. 195); Young et al. (2016, ds 2, ch. 233); Ristevski et al. (2018, ds 2, ch. 301); Smith et al. (in review, ds 1, ch. 306); Ősi et al. (2018, ds 1, ch. 346); Foffa et al. (2019, ch. 347).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. posteriorly or horizontally 1. anteriorly
376	**Anterior thoracic vertebrae, parapophysis in relation to the diapophysis:** *Young et al. (2012, ch. 188); Young (2014, ch. 196); Young et al. (2016, ds 2, ch. 234); Ristevski et al. (2018, ds 2, ch. 302); Smith et al. (in review, ds 1, ch. 307); Ősi et al. (2018, ds 1, ch. 347); Foffa et al. (2019, ch. 348).*

	Currently, there is not the information needed to score for most crocodylomorphs. Within Thalattosuchia, Neosteneosaurus edwardsi *and* Charitomenosuchus. leedsi *are state (0), and metriorhynchids score as state (1).* 0. parapophysis ventral to, or level with, diapophysis (when observed in lateral view) 1. parapophysis dorsal to diapophysis (when observed in lateral view)
377	**Anterior thoracic vertebrae, neural spine height relative to centrum height:** *Young et al. (2012, ch. 189); Young (2014, ch. 197); Young et al. (2016, ds 2, ch. 235); Ristevski et al. (2018, ds 2, ch. 303); Smith et al. (in review, ds 1, ch. 308); Ősi et al. (2018, ds 1, ch. 348); Foffa et al. (2019, ch. 349).* *Currently, there is not the needed information to score for most crocodylomorphs. Within Thalattosuchia,* Machimosaurus mosae *and* Neosteneosaurus edwardsi *are state (0), and* Charitomenosuchus leedsi *and metriorhynchids score as state (1).* 0. neural spine and centrum heights are approximately equal 1. neural spine height is less than centrum height
378	**Dorsal vertebrae, shape and relative positions of the neural spines:** *State (1) is a putative apomorphy of* Cricosaurus suevicus *(based on the lectotype and all referred specimens from the Nusplingen Plattenkalk).* 0. neural spines have the 'normal' shape – elongated, dorsal margin convex to weakly convex, and the neural spines of adjacent dorsals clearly separated from one another 1. neural spines are all rectangular when seen in lateral view, a flat dorsal margin is most prevalent, and the neural spines of adjacent dorsal vertebrae are very close to one another
379	**Sacral vertebra, number (= sacralisation of the first caudal vertebra):** *Buscalioni & Sanz (1988, ch. 44 mod.); Pol & Apesteguia (2005, ch. 115 mod.); Andrade et al. (2011, ch. 432); Ristevski et al. (2018, ds 2, ch. 304); Smith et al. (in review, ds 1, ch. 309); Ősi et al. (2018, ds 1, ch. 349); Foffa et al. (2019, ch. 350).* *The number of sacral vertebrae can be increased by the addition of last dorsal/lumbar or the first caudal, which constitute two divergent conditions, both leading to the total number of three sacral vertebrae (R. M. Santucci, pers. comm. 2004). Andrade et al. (2011) modified this character from the original to reflect this problem, although only the latter condition (addition of first caudal) has been reported so far (see for example, description in Pol 2005: p. 7-8). Note that the fusion of sacrals observed in* Alligatorellus *and* Montsecosuchus *(1st+2nd sacrals) is not homologous to the one reported by Pol (2005) for* Notosuchus *(2nd sacral+1st caudal).* *This character scores for a similar character as: Nesbitt (2011, ch. 207); Young et al. (2013a, ch. 159); Young et al. (2012, ch. 190); Young (2014, ch. 198); Young et al. (2016, ds 2, ch. 236). However, those characters referred to an "insertion" of a sacral vertebra between the first and second primordial sacral vertebrae.* *This character scores for the "third" sacral found in certain taxa (e.g.* Machimosaurus, Notosuchus, Mariliasuchus *and* Baurusuchus*).* *Within Thalattosuchia, evidence for three sacral vertebrae is found in Machimosaurini (*Lemmysuchus *and* Machimosaurus*).* 0. two 1. three, with the third being the first caudal vertebra
380	**Sacral vertebrae, shape of centra posterior face:** *Young (2014, ch. 199); Young et al. (2016, ds 2, ch. 237); Ristevski et al. (2018, ds 2, ch. 305); Smith et al. (in review, ds 1, ch. 310); Ősi et al. (2018, ds 1, ch. 350); Foffa et al. (2019, ch. 351).* *State (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* *Note that this character has a wider distribution than Young (2014) and Young et al. (2016, ds 2) thought (i.e. not restricted to Geosaurini).* 0. circular to sub-circular, with- or without an equatorial bulge 1. distinctly oval, transverse width noticeably greater than dorsoventral height
381	**Caudal vertebra, shape of caudal vertebra 1:**

	Ristevski et al. (2018, ds 2, ch. 306); Smith et al. (in review, ds 1, ch. 311); Ősi et al. (2018, ds 1, ch. 351); Foffa et al. (2019, ch. 352). *Character based on Clark (1994, ch. 94).* *State (1) occurs in* Theriosuchus, *bernissartiids and eusuchians.* 0. amphicoelous or amphyplatian 1. biconvex 2. procoelous
382	**Caudal vertebra, shape of the caudal vertebrae posterior to the first caudal:** *Ristevski et al. (2018, ds 2, ch. 307); Smith et al. (in review, ds 1, ch. 312); Ősi et al. (2018, ds 1, ch. 352); Foffa et al. (2019, ch. 353).* *Character based on Clark (1994, ch. 94).* 0. all are amphicoelous or amphyplatian 1. mixture of semi-procoelous, amphicoelous or amphyplatian 2. all are procoelous
383	**Caudal vertebrae, number:** *Young (2006, ch. 36 mod.); Wilkinson et al. (2008, ch. 64); Young & Andrade (2009, ch. 64); Young et al. (2011, ch. 64); Young et al. (2013a, ch. 160); Young et al. (2012, ch. 191); Young (2014, ch. 200); Young et al. (2016, ds 2, ch. 239); Ristevski et al. (2018, ds 2, ch. 308); Smith et al. (in review, ds 1, ch. 313); Ősi et al. (2018, ds 1, ch. 353); Foffa et al. (2019, ch. 354).* 0. less than 46 1. 50 or more
384	**Caudal vertebrae, relative height of neural spine:** *Andrade et al. (2011, ch. 435); Ristevski et al. (2018, ds 2, ch. 309); Smith et al. (in review, ds 1, ch. 314); Ősi et al. (2018, ds 1, ch. 354); Foffa et al. (2019, ch. 355).* *State (1) occurs in Dyrosauridae.* 0. larger spines are up to 2.5 times the height of vertebral body 1. spines are typically 2.5–4 times the height of vertebral body
385	**Caudal vertebrae, shape and orientation of the neural spines immediately in front of the flexural caudal vertebrae: (*) (ORDERED)** *State (1) occurs in* Gracilineustes*.* *State (2) occurs in* Rhacheosaurus *and* Cricosaurus*.* *This character is not applicable for taxa that do not have a 'tail fluke'.* 0. the neural spines are largely similar in shape to the other preflexural caudal vertebrae, although with some slight posterior orientation 1. the neural spines of the vertebrae immediately in front of the tail bend have a distinct morphology: they are dorsoventrally low, strongly inclined posteriorly such that the tips of the neural spines are slightly dorsal to the immediately posterior centrum 2. the neural spines of the five-to-six vertebrae immediately in front of the tail bend have a distinct morphology: they are dorsoventrally very low, strongly inclined posteriorly such that the tips of the neural spines are clearly dorsal to the immediately posterior centrum
386	**Caudal vertebrae, abrupt change in centrum cross-section at the distal end of the column:** *Andrade et al. (2011, ch. 436 part); Young et al. (2013a, ch. 161 part); Young et al. (2012, ch. 192 part); Young (2014, ch. 201 part); Young et al. (2016, ds 2, ch. 240 part); Ristevski et al. (2018, ds 2, ch. 310 part); Smith et al. (in review, ds 1, ch. 315 part); Ősi et al. (2018, ds 1, ch. 355); Foffa et al. (2019, ch. 356).* *State (1) is a putative apomorphy of Metriorhynchidae, but also occurs in* Magyarosuchus fitosi*. This suggests this character may have a wider distribution in Metriorhynchoidea.* *This character is an osteological correlate relating to the increase in distal tail lateral surface area. In taxa with a tail fin, this shape change is seen in both 'flexural', and post-flexural caudal vertebrae.* *All the characters relating to the tail fin morphological complex are present in known metriorhynchids; however, in plesiosaurians the presence of these characters is*

	variable between taxa, with no taxon having all the character states (Smith, 2013). Moreover, ichthyosaurs also show a gradual evolution of the tail bend and fin (see Motani, 2005). It is likely the morphological adaptations for a tail fin evolved in a mosaic manner in basal metriorhynchoids as well. *This character helps score the modification of the distal caudal vertebrae into a hypocercal tail.* 0. centra retain a sub-circular to sub-oval cross-section the same as, or similar to, that seen in proximal caudal vertebrae (i.e. the caudal vertebrae are isomorphic or poorly heteromorphic) 1. abrupt change in centrum shape, with strong mediolateral compression (distal vertebrae are clearly heteromorphic)
387	**Caudal vertebrae, shift in neural spine inclination near distal end:** *Andrade et al. (2011, ch. 436 part); Young et al. (2013a, ch. 161 part); Young et al. (2012, ch. 192 part); Young (2014, ch. 201 part); Young et al. (2016, ds 2, ch. 240 part); Ristevski et al. (2018, ds 2, ch. 310 part); Smith et al. (in review, ds 1, ch. 315 part); Ősi et al. (2018, ds 1, ch. 356); Foffa et al. (2019, ch. 357).* *State (1) is a putative apomorphy of Metriorhynchidae.* *The neural spines of the distal caudal vertebrae are unknown in* Magyarosuchus fitosi*.* *This character is an osteological correlate for a soft tissue structure along the dorsal margin of the distal tail, as the thickening and re-orientation of the neural spines support this structure. However, this structure need not be very large (i.e. a true upper lobe of a hypocercal tail).* *All the characters relating to the tail fin morphological complex are present in known metriorhynchids; however, in plesiosaurians the presence of these characters is variable between taxa, with no taxon having all the character states (Smith, 2013). Moreover, ichthyosaurs also show a gradual evolution of the tail bend and fin (see Motani, 2005). It is likely the morphological adaptations for a tail fin evolved in a mosaic manner in basal metriorhynchoids as well.* *This character helps score the modification of the distal caudal vertebrae into a hypocercal tail.* 0. no, distal caudal vertebral neural spines do not have a shift in orientation (being sub-vertical and/or posteriorly inclined) 1. yes, there is a distinct region of the distal caudal vertebrae that have a shift in neural spine orientation, changing from: a posterior inclination, to being sub-vertical, to having an anterior inclination
388	**Caudal vertebrae, ventral deflection of the distal end: (ORDERED)** *Young (2006, ch. 33 part); Wilkinson et al. (2008, ch. 61 part); Young & Andrade (2009, ch. 61 part); Young et al. (2011, ch. 61 part); Ősi et al. (2018, ds 1, ch. 357); Foffa et al. (2019, ch. 358).* *State (2) is a putative apomorphy of Metriorhynchidae.* *The presence of a ventral deflection of the distal caudal vertebrae is unknown in* Magyarosuchus fitosi*.* *This character helps define the lower lobe of a hypocercal tail. Note that in ichthyosaurs (Motani, 2005), the presence of a ventral deflection does not always mean there would have been a true upper lobe.* *All the characters relating to the tail fin morphological complex are present in known metriorhynchids; however, in plesiosaurians the presence of these characters is variable between taxa, with no taxon having all the character states (Smith, 2013). Moreover, ichthyosaurs also show a gradual evolution of the tail bend and fin (see Motani, 2005). It is likely the morphological adaptations for a tail fin evolved in a mosaic manner in basal metriorhynchoids as well.* *This character helps score the modification of the distal caudal vertebrae into a hypocercal tail.* *Note, most preserved metriorhynchid tails give an exaggerated angle, either due to how the vertebrae have been arranged (in disarticulated specimens) or the vertebrae are not fully in* in vivo *conditions (for specimens preserved in limestone).*

	The in vivo *condition is shown by retaining the curvature of the post-flexural caudal vertebrae.* *Note that juvenile specimens cannot be used to score this character (e.g.* Rhacheosaurus gracilis*) as there may be an ontogenetic increase in the angle, such as in ichthyosaurs.* 0. absent 1. present, tail bend angle is less than 10 degrees 2. present, tail bend angle is between 10-40 degrees 3. present, tail bend angle is greater than 40 degrees
389	**Caudal vertebrae, number of vertebrae involved in the tail deflection:** *Ősi et al. (2018, ds 1, ch. 358); Foffa et al. (2019, ch. 359).* *State (2) is a putative apomorphy of Metriorhynchidae.* *The presence of a ventral deflection of the distal caudal vertebrae is unknown in* Magyarosuchus fitosi. *This character helps define the lower lobe of a hypocercal tail. Note that in ichthyosaurs (Motani, 2005) the abruptness of the caudal series deflection varies between basal and derived clades, and in mosasaurids the tail bend is spread out across multiple vertebrae, similarly to basal ichthyosaurs (Lindgren et al. 2008, 2010). Therefore, a multi-state was created here to accommodate potential basal metriorhynchoids with a tail bend spread across a high number of caudal vertebrae. This character helps score the modification of the distal caudal vertebrae into a hypocercal tail.* *Note that juvenile specimens cannot be used to score this character (e.g.* Rhacheosaurus gracilis*) as there may be an ontogenetic increase in the angle, such as in ichthyosaurs.* 0. no ventral deflection of the distal caudal series 1. deflection is large, occurring over 15 to 30 vertebrae 2. deflection is abrupt, occurring over 5 to 10 vertebrae
390	**Caudal vertebrae, rapid centrum anteroposterior length reduction in postflexural caudal vertebrae: (*)** *State (1) occurs in* Cricosaurus *sp.* *This character is not applicable for taxa that do not have a 'tail fluke'.* 0. the centra become progressively 'smaller' in anteroposterior length and dorsoventral height as the neural arches regress 1. the centra rapidly become 'smaller' as the neural arches regress
391	**Axis rib:** *Young et al. (2012, ch. 193); Young (2014, ch. 202); Young et al. (2016, ds 2, ch. 241); Ristevski et al. (2018, ds 2, ch. 311); Smith et al. (in review, ds 1, ch. 316); Ősi et al. (2018, ds 1, ch. 359); Foffa et al. (2019, ch. 360).* *State (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* *Callovian teleosauroids have a distinct 'bump' or 'process' where a second articular head would be (see Andrews, 1913). However, in no specimen is there a second articular head preserved.* 0. holocephalous (rib elongate, with one articular head) 1. dichocephalous (rib triradiate, with two articular heads)
392	**Axis rib, tuberculum:** *Young & Andrade (2009, ch. 149); Young et al. (2011, ch. 149); Young et al. (2013a, ch. 162); Young et al. (2012, ch. 194); Young (2014, ch. 203); Young et al. (2016, ds 2, ch. 242); Ristevski et al. (2018, ds 2, ch. 312); Smith et al. (in review, ds 1, ch. 317); Ősi et al. (2018, ds 1, ch. 360); Foffa et al. (2019, ch. 361).* 0. wide with broad dorsal tip 1. narrow with acute dorsal tip

393	**Atlantal ribs, presence of very thin medial laminae at anterior end:** *Brochu (1999, ch. 16); Andrade et al. (2011, ch. 437); Ristevski et al. (2018, ds 1, ch. 437); Smith et al. (in review, ds 2, ch. 437); Ősi et al. (2018, ds 1, ch. 361); Foffa et al. (2019, ch. 362).* *State (1) is a putative apomorphy of Caimaninae.* 0. absent 1. present
394	**Cervical ribs, in lateral view, anteroposterior ridge of large, more posteriorly-placed cervical ribs: (NEW)** *See Figure 13 in Johnson et al. (2017)* *State (1) occurs in* Lemmysuchus obtusidens. 0. straight 1. dorsoventrally curved
395	**Dorsal ribs, positioning of tuberculum and articular facet: (NEW)** *See Figures 13 and 29 in Johnson et al. (2017)* *State (1) occurs in* Charitomenosuchus leedsi *and* Mycterosuchus nasutus. *State (2) occurs in* Neosteneosaurus edwardsi. *NB: this character is scored using the largest dorsal ribs (mid-thorax) in more complete specimens.* 0. medial edge 1. directly in the middle 2. lateromedial edge
396	**Dorsal rib, in lateral view, size tuberculum: (NEW)** *See Figure 29 in Johnson et al. (2017).* *State (1) occurs in* Sericodon jugleri*,* Charitomenosuchus leedsi, Macrospondylus bollensis *and* Aeolodon priscus*.* 0. pronounced 1. shallow
397	**Sacral vertebrae, relative position of lateral end of the transverse processes (= sacral ribs): (ORDERED)** *Young (2006, ch. 53 + 54); Wilkinson et al. (2008, ch. 81 + 82); Young & Andrade (2009, ch. 81 + 82); Andrade et al. (2011, ch. 433 + 434); Young et al. (2011, ch. 81 + 82); Young et al. (2013a, ch. 163 + 164); Young et al. (2012, ch. 195 + 196); Young (2014, ch. 204 + 205); Young et al. (2016, ds 2, ch. 243 + 244); Ristevski et al. (2018, ds 2, ch. 313); Smith et al. (in review, ds 2, ch. 318); Ősi et al. (2018, ds 1, ch. 362); Foffa et al. (2019, ch. 363).* *In Thalattosuchia the first sacral (as often the second) has its transverse processes at least poorly arched ventrally (see Andrews, 1913). In* Pelagosaurus typus *and metriorhynchids the transverse processes are strongly arched ventrally projecting the head for head contact with the ilium below the level of the cervical centrum (1), contrasting with teleosauroids (e.g.,* Steneosaurus*). However, in* Pelagosaurus typus*, the transverse processes are not as slender and does not project as ventrally.* *States (1+2) occur in Thalattosuchia.* *State (1) occurs in teleosauroids.* *State (2) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae.* 0. level with the vertebral centrum 1. transverse processes of sacral vertebra one lateroventrally directed, ventral relative to the vertebral centrum 2. transverse processes of both sacral vertebrae are lateroventrally directed, ventral relative to the vertebral centrum. In these taxa, the lateral ends of the transverse processes of both sacral vertebrae are typically significantly ventrally arched
398	**Second sacral vertebrae, posterior flange on the rib: (NEW)** *State (1) occurs in teleosauroids (note that in some teleosauroids such as* Lemmysuchus obtusidens, Charitomenosuchus leedsi, Machimosaurus mosae *and* Mycterosuchus nasutus *the flange is considerably larger and more pronounced*).

	0. anterior margin of the posterior area of the second sacral vertebra has a small, non-expanding flange 1. anterior margin of the posterior area of the second sacral vertebra has a large, expanded projecting flange
399	**Chevrons (= haemal arches), shape near the distal end of the caudal series:** *Young & Andrade (2009, ch. 164 mod.); Young et al. (2011, ch. 164 mod.); Young et al. (2013a, ch. 165 mod.); Young et al. (2012, ch. 197 mod.); Young (2014, ch. 206 mod.); Young et al. (2016, ds 2, ch. 245 mod.); Ristevski et al. (2018, ds 2, ch. 314 mod.); Smith et al. (in review, ds 1, ch. 319 mod.); Ősi et al. (2018, ds 1, ch. 363).; Foffa et al. (2019, ch. 364).* *State (1) is a putative apomorphy of Metriorhynchidae.* *The distal chevrons are unknown in* Magyarosuchus fitosi. *This character defines the change to the chevrons that stiffen the distal tail (seen ventral to 'flexural' and anterior post-flexural vertebrae).* *All the characters relating to the tail fin morphological complex are present in known metriorhynchids; however, in plesiosaurians the presence of these characters is variable between taxa, with no taxon having all the character states (Smith, 2013). Moreover, ichthyosaurs also show a gradual evolution of the tail bend and fin (see Motani, 2005). It is likely the morphological adaptations for a tail fin evolved in a mosaic manner in basal metriorhynchoids as well.* *This character helps score the modification of the distal tail into a tail fin.* 0. in lateral view they are either sub-triangular in shape or rod-like, in anterior view they are either 'V' or 'Y' shaped 1. in lateral view the main body of the chevron is mediolaterally compressed, deepening it dorsoventrally. In anterior view, some chevrons will have a slight 'W' shape, created by the midline anterior process being oriented anterodorsally
400	**Chevrons (= haemal arches), presence of a notch on the ventral margin of the distal chevrons:** *Ősi et al. (2018, ds 1, ch. 364); Foffa et al. (2019, ch. 365).* *State (1) is a putative apomorphy of* Metriorhynchus superciliosus. *However, note few metriorhynchids are known to preserve all/most of the flexural and postflexural chevrons. All studied metriorhynchid specimens preserved in limestone from the Late Jurassic of Germany lack these notches.* *This character can only be scored if there are multiple distal chevrons preserved, and they have the complete ventral margin.* 0. absent 1. present
401	**Chevrons (= haemal arches), nature of contact in distal chevrons:** *State (1) occurs in* Cricosaurus suevicus *and C. sp. However, note few metriorhynchids are known to preserve all/most of the flexural and postflexural chevrons.* *This character can only be scored if there are multiple distal chevrons preserved, and they have the complete anterior and posterior margins.* 0. if adjacent chevrons contact, they do so along their posterior-anterior margins 1. adjacent chevrons contact along the posteroventral-anterodorsal margins

Appendicular skeleton: pectoral girdle and forelimbs (Ch. 402 – 425; 4.887% of characters)

[pectoral elements (ossa coracoidea & ossa scapula); stylopodia (ossa humeri), zeugopodia (ossa radii & ossa ulnae), autopodia (ossa radialia/ulnaria, ossa metacarpalia, & ossa digitorum manus)]

#	Description
402	**Coracoid, shape:** *Young (2006, ch. 40); Wilkinson et al. (2008, ch. 69); Young & Andrade (2009, ch. 69); Young et al. (2011, ch. 69); Young et al. (2013a, ch. 166); Young et al. (2012,*

	ch. 198); Young (2014, ch. 207); Young et al. (2016, ds 2, ch. 246); Ristevski et al. (2018, ds 2, ch. 315); Smith et al. (in review, ds 1, ch. 320); Ősi et al. (2018, ds 1, ch. 365); Foffa et al. (2019, ch. 366). *State (1) occurs in teleosauroids.* *State (2) occurs in Metriorhynchoidea.* 0. neither proximal (i.e. glenoid region) nor distal (i.e. postglenoid process) ends are fan-shaped, having angular margins 1. distal end convex, forming a gentle fan-shape while the proximal end is triangular in shape with blunt ends 2. both proximal and distal ends are convex
403	**Coracoid, postglenoid process:** *Nesbitt (2011, ch. 223); Young et al. (2016, ds 2, ch. 247); Ristevski et al. (2018, ds 2, ch. 316); Smith et al. (in review, ds 1, ch. 321); Ősi et al. (2018, ds 1, ch. 366); Foffa et al. (2019, ch. 367).* *State (0) occurs in non-crocodylomorphs.* *State (1) occurs in 'sphenosuchians'.* *State (2) is a putative apomorphy of Crocodyliformes.* 0. short 1. elongate and expanded posteriorly only 2. elongate and expanded anteriorly and posteriorly
404	**Coracoid, posteroventral edge, deep groove:** *Nesbitt (2011, ch. 224); Young et al. (2016, ds 2, ch. 248); Ristevski et al. (2018, ds 2, ch. 317); Smith et al. (in review, ds 1, ch. 322); Ősi et al. (2018, ds 1, ch. 367); Foffa et al. (2019, ch. 368).* *State (1) occurs in Rauisuchiae and most 'sphenosuchians'.* 0. absent 1. present
405	**Scapula blade:** *Young et al. (2012, ch. 199 mod.); Young (2014, ch. 208, mod.); Young et al. (2016, ds 2, ch. 249 mod.); Ristevski et al. (2018, ds 2, ch. 318 mod.); Smith et al. (in review, ds 1, ch. 323 mod.); Ősi et al. (2018, ds 1, ch. 368); Foffa et al. (2019, ch. 369).* *State (1) is a putative apomorphy of Teleosauroidea.* *State (2) is a putative apomorphy of Metriorhynchidae.* 0. scapula blade large: approximately twice the width of the scapular shaft, and generally wider than the distal glenoid region 1. scapula blade reduced: being as wide as, or narrower than, the glenoid region; and the scapular blade is less than 1.5 times the width of the scapular shaft 2. scapula blade reduced: blade broadens both anteriorly and posteriorly, but is still as wide as, or narrower than, the glenoid region
406	**Scapula, anterior and posterior margins in lateral aspect:** *Young & Andrade (2009, ch. 105 mod.); Young et al. (2011, ch. 105 mod.); Young et al. (2013a, ch. 167 mod.); Young et al. (2012, ch. 200); Young (2014, ch. 209); Young et al. (2016, ds 2, ch. 250); Ristevski et al. (2018, ds 2, ch. 319); Smith et al. (in review, ds 1, ch. 324); Ősi et al. (2018, ds 1, ch. 369); Foffa et al. (2019, ch. 370).* 0. symmetrically concave in lateral view 1. anterior edge more strongly concave than posterior edge 2. posterior edge more strongly concave than anterior edge
407	**Scapula, deltoid crest:** *Young & Andrade (2009, ch. 106); Young et al. (2011, ch. 106); Young et al. (2013a, ch. 168); Young et al. (2012, ch. 201); Young (2014, ch. 210); Young et al. (2016, ds 2, ch. 251); Ristevski et al. (2018, ds 2, ch. 320); Smith et al. (in review, ds 1, ch. 325); Ősi et al. (2018, ds 1, ch. 370); Foffa et al. (2019, ch. 371).* 0. present 1. absent
408	**Scapula/Humerus, size:**

	Young (2006, ch. 39); Wilkinson et al. (2008, ch. 68); Young & Andrade (2009, ch. 68); Young et al. (2011, ch. 68); Young et al. (2013a, ch. 169); Young et al. (2012, ch. 202); Young (2014, ch. 211); Young et al. (2016, ds 2, ch. 252); Ristevski et al. (2018, ds 2, ch. 321); Smith et al. (in review, ds 1, ch. 326); Ősi et al. (2018, ds 1, ch. 371); Foffa et al. (2019, ch. 372). 0. humerus longer than scapula (greater than 15%) 1. humerus and scapula subequal in length (± 13%) 2. humerus shorter in length than scapula (less than 15%)
409	**Limb bones (forelimbs), proportional length of ulna relative to the humerus: (ORDERED)** *Andrade et al. (2011, ch. 452); Ristevski et al. (2018, ds 2, ch. 322); Smith et al. (in review, ds 1, ch. 327); Ősi et al. (2018, ds 1, ch. 372); Foffa et al. (2019, ch. 373).* *State (2) is a putative apomorphy of Thalattosuchia (not Teleosauroidea as putatively put forward by Andrade et al., 2011).* *In Thalattosuchia the ulna is typically between 48%–72% of the length of the humerus (perhaps being longer in juvenile specimens).* *State (2) also occurs in the* Pachycheilosuchus + Pietraroiasuchus *clade and* Anteophthalmosuchus*.* 0. ulna clearly longer than humerus 1. ulna subequal to humerus (distal/proximal = 75–125%) 2. ulna clearly shorter than the humerus
410	**Humerus, proximal region:** *Nesbitt (2011, ch. 232 mod.); Young et al. (2013a, ch. 170); Young et al. (2012, ch. 203 mod.); Young (2014, ch. 212); Young et al. (2016, ds 2, ch. 253 - added state 2); Ristevski et al. (2018, ds 2, ch. 323); Smith et al. (in review, ds 1, ch. 328); Ősi et al. (2018, ds 1, ch. 373); Foffa et al. (2019, ch. 374).* *In Thalattosuchia, derived teleosauroids (*Aeolodon priscus, Macrospondylus bollensis, Charitomenosuchus leedsi, Neosteneosaurus edwardsi*) have state (2) - the posterior deflection being much more pronounced than in other thalattosuchians.* *In Geosaurini and Rhacheosaurini taxa change to state (0).* 0. confined to the proximal surface 1. posteriorly expanded and hooked 2. very strongly posteriorly deflected and hooked, with the proximal epiphysis noticeably posterior to the distal epiphysis
411	**Humerus, proximomedial articular surface:** *Young & Andrade (2009, ch. 107); Young et al. (2011, ch. 107); Young et al. (2013a, ch. 171); Young et al. (2012, ch. 204); Young (2014, ch. 213); Young et al. (2016, ds 2, ch. 254); Ristevski et al. (2018, ds 2, ch. 324); Smith et al. (in review, ds 1, ch. 329); Ősi et al. (2018, ds 1, ch. 374); Foffa et al. (2019, ch. 375).* *State (1) occurs in* Rhacheosaurus *and* Cricosaurus*.* 0. strongly convex 1. weakly convex
412	**Humerus, deltopectoral crest:** *Young (2006, ch. 38 modified); Wilkinson et al. (2008, ch. 66 mod.); Young & Andrade (2009, ch. 66 mod.); Young et al. (2011, ch. 66 mod.); Young et al. (2013a, ch. 172); Young et al. (2012, ch. 205); Young (2014, ch. 214); Young et al. (2016, ds 2, ch. 255); Ristevski et al. (2018, ds 2, ch. 325); Smith et al. (in review, ds 1, ch. 330); Ősi et al. (2018, ds 1, ch. 375); Foffa et al. (2019, ch. 376).* *State (1) is a putative apomorphy of Metriorhynchidae.* *Young et al. (2013a) removed state (2) (absent/vestigial) as metriorhynchids of the subclade Rhacheosaurini do indeed have a deltopectoral crest on their humeri.* 0. present and distinct from the proximal surface 1. present, but continuous with the proximal surface
413	**Humerus, shape:**

	Young et al. (2012, ch. 206); Young (2014, ch. 215); Young et al. (2016, ds 2, ch. 256); Ristevski et al. (2018, ds 2, ch. 326); Smith et al. (in review, ds 1, ch. 331); Ősi et al. (2018, ds 1, ch. 376); Foffa et al. (2019, ch. 377). *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. has typical long bone morphology (longer than wide at distal end) 1. broadly expanded and plate-like
414	**Humerus, length of the diaphysis relative to total humerus length:** *Wilkinson et al. (2008, ch. 67); Young & Andrade (2009, ch. 67); Young et al. (2011, ch. 67); Young et al. (2013a, ch. 173); Young et al. (2012, ch. 207); Young (2014, ch. 216); Young et al. (2016, ds 2, ch. 257); Ristevski et al. (2018, ds 2, ch. 327); Smith et al. (in review, ds 1, ch. 332); Ősi et al. (2018, ds 1, ch. 377); Foffa et al. (2019, ch. 378).* *This character quantifies the reduction in humeral shaft size in Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. diaphysis contributing more than 50% of total humeral length 1. diaphysis contributes 35–38% of total humeral length 2. diaphysis contributes less than 25% of total humeral length
415	**Humerus-antebrachium joint surface:** *Young et al. (2011, ch. 180); Young et al. (2013a, ch. 174); Young et al. (2012, ch. 208); Young (2014, ch. 217); Young et al. (2016, ds 2, ch. 258); Ristevski et al. (2018, ds 2, ch. 328); Smith et al. (in review, ds 1, ch. 333); Ősi et al. (2018, ds 1, ch. 378); Foffa et al. (2019, ch. 379).* *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. complex, allowing one degree of motion – i.e. the humeral epiphyses are ossified 1. planar, limiting possible motion – i.e. the humeral epiphyses are unossified
416	**Radius and/or ulna, shape:** *Young (2006, ch. 37); Wilkinson et al. (2008, ch. 65); Young & Andrade (2009, ch. 65); Young et al. (2011, ch. 65 + 176); Young et al. (2013a, ch. 175 + 177); Young et al. (2012, ch. 209 + 211); Young (2014, ch. 218 + 220); Young et al. (2016, ds 2, ch. 259 + 261); Ristevski et al. (2018, ds 2, ch. 329); Smith et al. (in review, ds 1, ch. 334); Ősi et al. (2018, ds 1, ch. 379); Foffa et al. (2019, ch. 380).* *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. typical long bone morphology (proximodistal length noticeably greater than width at distal end) 1. broadly expanded and plate-like
417	**Radius and ulna, length relative to one another: (NEW)** *State (1) occurs in* Mycterosuchus nasutus. 0. relatively the same size 1. ulna more than 25% larger than the radius
418	**Ulna, axis length:** *Ősi et al. (2018, ds 1, ch. 380); Foffa et al. (2019, ch. 381).* *State (1) is a putative apomorphy of Rhacheosaurini.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. the proximodistal axis length of the ulna is greater than the length of the anteroposterior axis 1. the anteroposterior axis length of the ulna is greater than the length of the proximodistal axis
419	**Ulna, morphology of olecranon process:**

	Brochu (1999, ch. 27); Turner & Buckley (2008, ch. 260); Andrade et al. (2011, ch. 457); Ristevski et al. (2018, ds 1, ch. 459); Smith et al. (in review, ds 2, ch. 459); Ősi et al. (2018, ds 1, ch. 381); Foffa et al. (2019, ch. 382). 0. narrow and subangular 1. wide and rounded
420	**Ulna, olecranon process mediolaterally compressed and greatly expanded, creating a very broad proximal ulna:** *Ősi et al. (2018, ds 1, ch. 382); Foffa et al. (2019, ch. 383).* *State (1) occurs in derived teleosauroids.* *Basal teleosauroids (such as* Platysuchus multiscrobiculatus *and* Macrospondylus bollensis*) score as (0).* 0. no 1. yes
421	**Radiale and/or ulnare, shape:** *Young et al. (2011, ch. 177 + 179); Young et al. (2013a, ch. 176 + 178); Young et al. (2012, ch. 210 + 212); Young (2014, ch. 219 + 221); Young et al. (2016, ds 2, ch. 260 + 262); Ristevski et al. (2018, ds 2, ch. 330); Smith et al. (in review, ds 1, ch. 335); Ősi et al. (2018, ds 1, ch. 383); Foffa et al. (2019, ch. 384).* *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* 0. typical long bone morphology (proximodistal length noticeably greater than width at distal end) 1. broadly expanded and plate-like
422	**Manus, metacarpal general structure: (*)** *Buscalioni (2017, ch. 424 mod., part); Ősi et al. (2018, ds 1, ch. 384); Foffa et al. (201 ch. 385).* *Ősi et al. (2018) modified the character from Buscalioni (2017) to help quantify the manus morphological changes occurring at the transition from basal crocodyliforms to metasuchians. Here it samples overall robustness, not relative length.* *This character is not applicable for taxa that do not have all five manual digits.* 0. metacarpals IV and V not strongly differentiated from II-III in terms of overall robusticity 1. metacarpals II-III are noticeably more robust than those of IV-V (due to metacarpal I being greatly enlarged relative to all other metacarpals in some clades, it is not used in this character)
423	**Manus, shape of metacarpal I: (*)** *Young (2006, ch. 41); Wilkinson et al. (2008, ch. 70); Young & Andrade (2009, ch. 70); Young et al. (2011, ch. 70); Young et al. (2013a, ch. 179); Young et al. (2012, ch. 213); Young (2014, ch. 222); Young et al. (2016, ds 2, ch. 263); Ristevski et al. (2018, ds 2, ch. 331); Smith et al. (in review, ds 1, ch. 336); Ősi et al. (2018, ds 1, ch. 385); Foffa et al. (2019, ch. 386).* *State (1) is a putative apomorphy of Metriorhynchidae.* *This character helps score the modification of the manus into paddles, and the general reduction of the forelimbs, in Metriorhynchidae.* *This character is not applicable for taxa that lack digit I.* 0. elongate, more than twice as long as wide 1. broadly expanded, maximum width at least 60% of total length
424	**Manus, digit I:** *Ősi et al. (2018, ds 1, ch. 386); Foffa et al. (2019, ch. 387).* *State (1) is a putative apomorphy of* Junggarsuchus*.* *This character helps score the modification of the manus into being functionally tridactyl.* 0. present 1. absent
425	**Manus, relative length of digit V: (*)** *Buscalioni (2017, ch. 424 mod., part); Ősi et al. (2018, ds 1, ch. 387); Foffa et al. (201*

	ch. 388). *Ősi et al. (2018) modified the character from Buscalioni (2017) to help quantify the manus morphological changes occurring at transition from basal crocodyliforms to metasuchians.* *This character is not applicable for taxa that do not have all five manual digits.* 0. digit V longer than digit I, being comparable in length to digits II-IV 1. digit V reduced in length, being evidently shorter than digits II-IV and comparable in length to digit I

Appendicular skeleton: pelvic girdle and hind limbs (Ch. 426 – 471; 9.368% of characters)
[pelvic elements (ossa pubes, ossa ilia, & ossa ischia); stylopodia (ossa femora), zeugopodia (ossa tibiae), autopodia (ossa calcis, ossa metatarsalia, & ossa digitorum pedis)]

#	Description
426	**Pubis, exclusion from acetabulum:** *Turner & Sertich (2010, ch. 86 part); Andrade et al. (2011, ch. 445); Young et al. (2013a, ch. 180 part); Young et al. (2012, ch. 214 part); Young (2014, ch. 223 part); Young et al. (2016, ds 2, ch. 264 part); Ristevski et al. (2018, ds 2, ch. 332); Smith et al. (in review, ds 1, ch. 337); Ősi et al. (2018, ds 1, ch. 388); Foffa et al. (2019, ch. 389).* *Following Claesson (2004) state (1) occurs in Crocodyliformes.* *This character scores the pubis articulation with the acetabulum (state 0), and the mobile pubis articulating with the ischium anterior process (state 1).* 0. pubis not excluded, participating at least marginally to the anteroventral rim of the acetabulum 1. pubis excluded, acetabulum composed exclusively by the ischium and ilium
427	**Pubis, presence of exclusive proximal contact with ischium:** *Andrade et al. (2011, ch. 446) – based on Andrews (1913) and Clark (1994, ch. 86); Ristevski et al. (2018, ds 2, ch. 333); Smith et al. (in review, ds 1, ch. 338); Ősi et al. (2018, ds 1, ch. 389); Foffa et al. (2019, ch. 390).* *Note that in Metasuchia this character correlates with the pubic exclusion from the acetabulum; however, thalattosuchians also have the pubis excluded from the acetabulum, but the pubis articulates between the ischium pubic process and the ilium anterior peduncle.* 0. absent, pubis supported by both ilium and ischium 1. present, proximal head of pubis contacts only the ischium
428	**Pubis, length:** *Nesbitt (2011, ch. 278); Young et al. (2016, ds 2, ch. 265); Ristevski et al. (2018, ds 2, ch. 334); Smith et al. (in review, ds 1, ch. 339); Ősi et al. (2018, ds 1, ch. 390); Foffa et al. (2019, ch. 391).* *State (0) is a putative apomorphy of Crocodyliformes.* 0. less than 70% of femoral length 1. 70% or more of femoral length
429	**Pubis, expansion of distal end** *Clark (1994, ch. 85 mod.); Andrade et al. (2011, ch. 447 mod.); Nesbitt (2011, ch. 283 mod.); Ristevski et al. (2018, ds 2, ch. 335); Smith et al. (in review, ds 1, ch. 340); Ősi et al. (2018, ds 1, ch. 391); Foffa et al. (2019, ch. 392).* *Note that* Postosuchus *has a pubic boot (along with other non-crocodylomorph pseudosuchians; Nesbitt, 2011; Weinbaum, 2013). Here we test the homology of this pubic boot with that seen in crocodylomorphs (the* Protosuchus *distal expansion, and the 'fan'-like pubic blade seen in other crocodyliforms). Nesbitt (2011) reports that a small posterior expansion is present in the holotype of* Hesperosuchus agilis*, suggesting the lack of an expansion in* Terrestrisuchus *is apomorphic.*

	State (2) is a putative apomorphy of Mesoeucrocodylia. 0. absent 1. expanded relative to the shaft (= pubic boot) 2. a “fan-like” expansion creating a distinct pubic blade
430	**Pubis, shape of proximal rim of distal pubic blade: (NEW)** *State (1) occurs in Machimosaurini*, Sericodon jugleri*,* Charitomenosuchus leedsi, Macrospondylus bollensis, *and* Neosteneosaurus edwardsi. 0. straight and square-like 1. curved and rounded
431	**Pubis, length of pubic shaft: (NEW)** *State (1) occurs in* Mycterosuchus nasutus. 0. shorter (less than 50%) than pubic plate 1. equal in length or longer (greater than 50%) of pubic plate
432	**Pubis, presence of an obturator foramen:** *Leardi et al. (2017, ch. 126); Ősi et al. (2018, ds 1, ch. 392); Foffa et al. (2019, ch. 393).* *State (1) occurs in Crocodyliformes.* 0. present 1. absent
433	**Ilium, presence of a distinct anterior acetabular flange, created by the anterior acetabular margin projecting anteriorly such that it is anterior to the iliac anterior margin:** *Smith et al. (in review, ds 1, ch. 341); Ősi et al. (2018, ds 1, ch. 393); Foffa et al. (2019, ch. 394).* *State (1) occurs in basal metriorhynchoids*. *Note, this condition is different from that of* Dyrosaurus maghribensis*, as there the entire anterior margin of the ilium bulges anteriorly, not just the acetabular margin (which in* Pelagosaurus typus *creates the thin acetabular flange).* 0. absent 1. present
434	**Ilium, shape of anterior iliac process: (NEW)** *See Figures 17 and 24 in Johnson et al. (2017).* *State (1) occurs in* Lemmysuchus obtusidens, *and Metriorhynchidae.* 0. long and slender 1. short and robust
435	**Ilium, relative length of anterior and posterior processes: (*)** *Clark (1994, ch. 84); Lauprasert et al. (2007, ch. 68); Andrade et al. (2011, ch. 441); Ristevski et al. (2018, ds 1, ch. 441); Smith et al. (in review, ds 2, ch. 441); Ősi et al. (2018, ds 1, ch. 394); Foffa et al. (2019, ch. 395).* *This character is not applicable for taxa that lack the posterior process of the ilium.* 0. subequal, anterior and posterior processes similar in length 1. unequal, with anterior process relatively small, one quarter or less than the length of the posterior process
436	**Ilium, presence of indentation at the dorsal margin of iliac blade:** *Brochu (1999, ch. 28 mod., part); Andrade et al. (2011, ch. 442); Ristevski et al. (2018, ds 1, ch. 442); Smith et al. (in review, ds 2, ch. 442); Ősi et al. (2018, ds 1, ch. 395); Foffa et al. (2019, ch. 396).* *Andrade et al. (2011) divided this character to separate diverse aspects of the morphology of the anterior end of iliac blade. This character samples the indentation at the dorsal edge of the anterior process.* 0. absent, dorsal edge convex or straight in lateral view 1. present as a shallow or modest dorsal indentation 2. present as a strong dorsal indentation (“wasp-waisted”)

437	**Ilium, presence of a distinct 'bulge' that fuses the anterior regions of the supraacetabular and dorsal iliac crests: (*)** *Ristevski et al. (2018, ds 2, ch. 336); Smith et al. (in review, ds 1, ch. 342); Ősi et al. (in review, ds 1, ch. 396); Foffa et al. (2019, ch. 397).* *State (1) occurs in* Anteophthalmosuchus hooleyi *and* Crocodylus. *This character is not applicable for taxa that lack the dorsal iliac crest.* 0. anterior region of the supraacetabular crest does not fuse with the anterior margin of the iliac dorsal crest, as there is no anterior 'bulge' 1. anterior region of the crest bulges laterally (slightly overhanging the acetabular fossa), and is contiguous with the anterior margin of the iliac dorsal crest
438	**Complexity of supraacetabular iliac crest in medial view: (NEW)** *See Figure 17 in Johnson et al. (2017).* *State (1) occurs in* Lemmysuchus obtusidens *and* Machimosaurus mosae. *NB:* Platysuchus *and* Teleosaurus *have large, well-pronounced supraacetabular crests.* 0. crest is pronounced 1. crest is shallow and poorly-developed
439	**Ilium, postacetabular (= posterior) process presence:** *Young & Andrade (2009, ch. 128 mod.), Young et al. (2011, ch. 128 mod.); Young et al. (2013a, ch. 181 mod.); Young et al. (2012, ch. 215 mod.); Young (2014, ch. 224); Wilberg (2015b, ch. 368); Young et al. (2016, ds 2, ch. 266 mod.); Ristevski et al. (2018, ds 2, ch. 337); Smith et al. (in review, ds 1, ch. 343); Ősi et al. (2018, ds 1, ch. 397); Foffa et al. (2019, ch. 398).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. present 1. absent/extremely reduced
440	**Ilium, postacetabular (= posterior) process expanded into a thin "fan"-shape: (*)** *Young et al. (2012, ch. 216); Young (2014, ch. 225); Wilberg (2015b, ch. 369); Young et al. (2016, ds 2, ch. 267); Ristevski et al. (2018, ds 2, ch. 338); Smith et al. (in review, ds 1, ch. 344); Ősi et al. (2018, ds 1, ch. 398); Foffa et al. (2019, ch. 399).* *State (1) is a putative apomorphy of derived teleosauroids (not seen in basal taxa* Platysuchus multiscrobiculatus, Teleosaurus cadomensis, Sericodon jugleri, Plagiophthalmosuchus gracilirostris *and* Macrospondylus bollensis *where the process is still elongate and distinctly process-like). This structure is a modification of the postacetabular (=posterior) process in these taxa.* *This character is not applicable for taxa that lack the postacetabular process.* 0. no 1.yes, posterior margin is expanded (typically resembling a "fan"-shape), being mediolaterally compressed and extends from the iliac crest towards the posterior peduncle
441	**Ilium, postacetabular (= posterior) process, presence of constrictions ('wasp-waisting') on both the dorsal and ventral margins near the distal terminus: (*)** *Ristevski et al. (2018, ds 2, ch. 339); Smith et al. (in review, ds 1, ch. 345); Ősi et al. (2018, ds 1, ch. 399); Foffa et al. (2019, ch. 400).* *State (1) occurs in* Anteophthalmosuchus epikrator *and* Crocodylus. *This character is not applicable for taxa that lack the postacetabular process.* 0. absent 1. present
442	**Ilium, size:** *Young (2006, ch. 42); Wilkinson et al. (2008, ch. 71); Young & Andrade (2009, ch. 71); Young et al. (2011, ch. 71); Young et al. (2013a, ch. 182); Young et al. (2012, ch. 217); Young (2014, ch. 226); Young et al. (2016, ds 2, ch. 268); Ristevski et al. (2018, ds 2, ch. 340); Smith et al. (in review, ds 1, ch. 346); Ősi et al. (2018, ds 1, ch. 400); Foffa et al. (2019, ch. 401).* *State (1) is a putative apomorphy of Metriorhynchidae.*

	0. large (length of dorsal border more than 28%, and typically at least 30% of femur length) 1. small (length of dorsal border less than 21% of femur length)
443	**Ilium, in lateral view, the orientation of the dorsal margin of the articulation facet that contributes to the acetabulum is:** *Young (2014, ch. 227); Young et al. (2016, ds 2, ch. 269); Ristevski et al. (2018, ds 2, ch. 341); Smith et al. (in review, ds 1, ch. 347); Ősi et al. (in review, ds 1, ch. 401); Foffa et al. (2019, ch. 402).* *State (1) is a putative autapomorphy of* Tyrannoneustes lythrodectikos. 0. ventrally orientated 1. horizontally orientated
444	**Ilium, dorsal border length in lateral view:** *Young (2014, ch. 228); Young et al. (2016, ds 2, ch. 270); Ristevski et al. (2018, ds 2, ch. 342); Smith et al. (in review, ds 1, ch. 348); Ősi et al. (2018, ds 1, ch. 402); Foffa et al. (2019, ch. 403).* *State (1) is a putative autapomorphy of* Tyrannoneustes lythrodectikos. 0. long, terminates at least level to the articulation facet that contributes to the acetabulum 1. short, terminates prior to the articulation facet that contributes to the acetabulum
445	**Ilium, ventral margin:** *Ristevski et al. (2018, ds 2, ch. 343); Smith et al. (in review, ds 1, ch. 349); Ősi et al. (2018, ds 1, ch. 403); Foffa et al. (2019, ch. 404).* *State (1) is a putative apomorphy of Metriorhynchidae.* 0. distinct ilium and ischium peduncles separated by an acetabular incision/depression 1. lacks an acetabular depression, with the peduncles being contiguous with the ventral margin
446	**Ischium, presence of pubic (= anterior) process:** *Andrade et al. (2011, ch. 444) – reformulated from Clark (1994, ch. 86) and Andrews (1913); Ristevski et al. (2018, ds 1, ch. 446); Smith et al. (in review, ds 2, ch. 446); Ősi et al. (2018, ds 1, ch. 404); Foffa et al. (2019, ch. 405).* 0. pubic process absent, or incipient and small, not restricting the participation of the pubis to the acetabulum 1. anterior process well developed, robust and with a round head, at least partially restricting the participation of pubis in the acetabulum
447	**Ischium, morphology of pubic (= anterior) process: (*)** *Young (2006, ch. 43); Wilkinson et al. (2008, ch. 72); Young & Andrade (2009, ch. 72); Young et al. (2011, ch. 72); Young et al. (2013a, ch. 183); Young et al. (2012, ch. 218); Young (2014, ch. 229); Young et al. (2016, ds 2, ch. 271); Ristevski et al. (2018, ds 2, ch. 344); Smith et al. (in review, ds 1, ch. 350); Ősi et al. (2018, ds 1, ch. 405); Foffa et al. (2019, ch. 406).* *State (1) is a putative apomorphy of Metriorhynchidae.* *State (2) is a putative apomorphy of* Cricosaurus*.* *This character is not applicable for taxa that lack, or have incipient pubic processes.* 0. developed – with clearly defined articulation facets for pubis and ilium; additionally, anterior process is at least half as wide as the posterior process 1. reduced – lacks both articulation facets, and is between 30–50% as wide as the posterior process 2. highly reduced – lacking both articulation facets, and is less than 25% as wide as the posterior process

448	**Ischium, morphology of anterior process of iliac blade, in lateral view:** *Brochu (1999, ch. 28 mod., part); Andrade et al. (2011, ch. 443); Ristevski et al. (2018, ds 1, ch. 443); Smith et al. (in review, ds 2, ch. 443); Ősi et al. (2018, ds 1, ch. 406); Foffa et al. (2019, ch. 407).* *Andrade et al. (2011) divided this character to separate diverse aspects of the morphology of the anterior end of iliac blade. This character samples the morphology of the anterior process. Among eusuchians, state (1) is a somewhat generalised condition; state (0) is putative apomorphy of* Paleosuchus*; and state (2) is putative apomorphy of* Diplocynodon*.* 0. very narrow relative the main body of the iliac blade 1. rounded and moderately broad relative the main body of the iliac blade 2. very broad and deep, at least half the height of the main body of the iliac blade
449	**Ischium, shape of posteroventral margin of ischial plate: (NEW)** *See Figure 17 in Johnson et al. (2017, Fig. 17).* *State (1) occurs in Machimosaurini.* 0. triangular 1. sub-square
450	**Limb bones, length relative to trunk, at maturity: (ORDERED)** *Brochu (1999, ch. 33 mod.); Andrade et al. (2011, ch. 448); Ristevski et al. (2018, ds 1, ch. 450); Smith et al. (in review, ds 2, ch. 450); Ősi et al. (2018, ds 1, ch. 407); Foffa et al. (2019, ch. 408).* *Andrade et al. (2011) modified this character to sample length relative to trunk, not overall robustness.* *Within Eusuchia, Brochu (1999) considers that state (2) only occurs in* Borealosuchus*.* 0. limb bones relatively short 1. limb bones moderately long 2. limb bones very long
451	**Limb bones, general structure:** *Brochu (1999, ch. 33 part); Andrade et al. (2011, ch. 449); Ristevski et al. (2018, ds 1, ch. 451); Smith et al. (in review, ds 2, ch. 451); Ősi et al. (2018, ds 1, ch. 408); Foffa et al. (2019, ch. 409).* *Andrade et al. (2011) modified this character was to sample overall robustness, not relative length. Within Eusuchia, Brochu (1999) considers that state (2) only occurs in* Borealosuchus*.* 0. limb bones robust 1. limb bones overall slender, but not weak 2. gracile
452	**Limb bones, relative length of forelimbs/hindlimbs (= *humerus* + *radius* : *femur* + *tibia*):** *Brochu (1999, ch. 33 part); Young & Andrade (2009, ch. 109 mod.); Andrade et al. (2011, ch. 450 mod.); Nesbitt (2011, ch. 212 mod.); Young et al. (2011, ch. 109 mod.); Young et al. (2013a, ch. 195 mod.); Young et al. (2012, ch. 230 mod.); Young (2014, ch. 241 mod.); Young et al. (2016, ds 2, ch. 284 mod.); Ristevski et al. (2018, ds 2, ch. 345); Smith et al. (in review, ds 1, ch. 351); Ősi et al. (2018, ds 1, ch. 409); Foffa et al. (2019, ch. 410).* *Andrade et al. (2011) modified the crocodylomorph variant of this character to sample relative length of limbs, not robustness or limb/trunk relative length. This version of the character is an amalgam of the ones in Andrade et al. (2011) and Nesbitt (2011), the latter which Young et al. (2016, ds 2) modified to include extra states to reflect the forelimb reduction in Thalattosuchia.* *This character does not consider the autopodia (manus and pes), only the relation between the stylopodia and zeugopodia (humerus + ulna and femur + tibia, respectively).* *States (3 + 4) reflects the extreme conditions found in Thalattosuchia. State (4) evolved twice, once in Metriorhynchidae, and also in derived teleosauroids (the Middle Jurassic '*Steneosaurus*' clade).*

	Note that basal thalattosuchians (e.g. Macrospondylus bollensis, Platysuchus multiscrobiculatus *and* Pelagosaurus typus*) have state (2).* *State (2) also occurs in* Gavialis *and* Terminonaris*.* *State (3) also evolved in the* Pachycheilosuchus + Pietraroiasuchus *clade.* *Basal crocodylomorphs also share state (2), while state (3) occurs in* Postosuchus*.* *Within Eusuchia, Brochu (1999) considers that state (0) only occurs in* Borealosuchus*.* 0. forelimb and hindlimb subequal in length at maturity 1. forelimb slightly shorter than hindlimb at maturity 2. forelimb shorter than hindlimb at maturity (between 90 and 55%) 3. forelimb noticeably shorter than hindlimb at maturity (between 45 and 55%) 4. forelimb significantly shorter than hindlimb at maturity (less than 45%)
453	**Limb bones (hindlimbs), proportional length of tibia relative to the femur: (ORDERED)** *Clark et al. (2000, ch. 31 mod.); Clark & Sues (2002, ch. 32 mod.); Sues et al. (2003, ch. 32 mod.); Clark et al. (2004, ch. 32 mod.); Young (2006, ch. 44 mod.); Wilkinson et al. (2008, ch. 73 mod.); Young & Andrade (2009, ch. 73 mod.); Andrade et al. (2011, ch. 453 mod.); Young et al. (2012, ch. 225 + 231 mod.); Pol et al. (2013, ch. 32 mod.); Young et al. (2016, ds 2, ch. 278 mod.); Leardi et al. (2017, ch. 32 mod.); Ristevski et al. (2018, ds 1, ch. 455 mod.); Smith et al. (in review, ds 2, ch. 455 mod.); Ősi et al. (2018, ds 1, ch. 410); Foffa et al. (2019, ch. 411).* *This version of the character is an amalgam of the ones in Andrade et al. (2011), Young et al. (2016) and Leardi et al. (2017).* *This character is designed to help elucidate variation in the proportions of the hind limb, and the changes that occur in Thalattosuchia (where the femur can be almost twice the size of tibia, i.e. in Metriorhynchidae). Thus states (2-5) are putative apomorphies of Thalattosuchia.* *State (0) occurs in* Terrestrisuchus, *Hallopodidae, and* Gobiosuchus*.* *In Thalattosuchia, state (4) is a putative apomorphy of both Metriorhynchinae and* Aeolodon priscus*, with derived metriorhynchines being state (5). Middle Jurassic teleosauroids (and the Late Jurassic genus* Machimosaurus*) and Geosaurinae score as state (3).* *Thus, this character is scoring for the independent regression of the tibia (as a proportion of the hind limb) in Teleosauroidea and Metriorhynchidae.* *State (2) also occurs in Dyrosauridae and* Terminonaris*.* 0. length uneven, tibia slightly longer than the femur (distal/proximal more than 105%) 1. tibia subequal to femur, or only slightly shorter (distal/proximal c. 75-100%) 2. length uneven, tibia evidently shorter than the femur (distal/proximal c. 50-74%) 3. length uneven, tibia evidently shorter than the femur (distal/proximal c. 40-50%) 4. length uneven, tibia evidently shorter than the femur (distal/proximal c. 30-40%) 5. length uneven, tibia evidently shorter than the femur (distal/proximal less than 30%)
454	**Femur, relative orientation between the proximal and distal heads:** *Ortega et al. (2000, ch. 149), Andrade et al. (2011, ch. 455); Ristevski et al. (2018, ds 1, ch. 457); Smith et al. (in review, ds 2, ch. 457); Ősi et al. (2018, ds 1, ch. 411); Foffa et al. (2019, ch. 412).* 0. femur with light torsion, proximal and distal articulation facets approximately at 30 degrees or less from each other 1. femur with evident torsion, proximal and distal articulation facets approximately at 60 degrees from each other
455	**Femur, general shape:** *Andrade et al. (2011, ch. 464 mod.); Ristevski et al. (2018, ds 2, ch. 347 mod.); Smith et al. (in review, ds 1, ch. 353 mod.); Ősi et al. (2018, ds 1, ch. 412); Foffa et al. (2019, ch. 413).* *State (1) is a putative apomorphy of Thalattosuchia.*

	0. sigmoidal shape formed by either an unequal proximal and distal curvature, or a strong sigmoidal shape 1. sigmoidal shape formed by comparable curvatures proximally and distally, and forms a shallow 'S'-shape
456	**Femur, in dorsal view, shape of femoral head in relation to anteromedial tuber: (NEW)** *State (1) occurs in* Mycterosuchus nasutus. 0. present, and small 1. present, and largest of the proximal tubera
457	**Femur, proximal portion, posteromedial tuber:** *Nesbitt (2011, ch. 301 mod. – character states re-ordered); Young et al. (2013a, ch. 184); Young et al. (2012, ch. 219); Young (2014, ch. 230); Young et al. (2016, ds 2, ch. 272); Ristevski et al. (2018, ds 2, ch. 348); Smith et al. (in review, ds 1, ch. 354); Ősi et al. (2018, ds 1, ch. 413); Foffa et al. (2019, ch. 414).* *State (2) is a putative apomorphy of Metriorhynchoidea.* *State (2) also occurs in non-paracrocodylomorph pseudosuchians.* 0. absent 1. present, and small 2. present, and largest of the proximal tubera
458	**Femur, proximal condylar fold:** *Nesbitt (2011, ch. 312); Young et al. (2013a, ch. 185); Young et al. (2012, ch. 220); Young (2014, ch. 231); Young et al. (2016, ds 2, ch. 273); Ristevski et al. (2018, ds 2, ch. 349); Smith et al. (in review, ds 1, ch. 355); Ősi et al. (2018, ds 1, ch. 414); Foffa et al. (2019, ch. 415).* *State (1) occurs in Paracrocodylomorpha.* *The proximal condylar fold is a straight ridge that connects the medioventral portion of the ventral head with the shaft on the anterolateral surface of the femur (Nesbitt 2011: p. 149).* *Note that this fold can be hard to discern in Metriorhynchidae. It is possible that derived species of* Cricosaurus *lack this fold.* 0. absent 1. present
459	**Femur, size of distal medial and lateral condyles relative to one another: (NEW)** *State (1) occurs in* Mycterosuchus nasutus, Charitomenosuchus leedsi, Neosteneosaurus edwardsi, *and* Machimosaurus. 0. medial and lateral condyle relatively the same size 1. medial condyle noticeably larger than lateral condyle
460	**Femur, ridge of attachment for the *M. caudofemoralis*:** *Young & Andrade (2009, ch. 108 mod.); Nesbitt (2011, ch. 315 mod.); Young et al. (2011, ch. 108 mod.); Young et al. (2013a, ch. 186); Young et al. (2012, ch. 221); Young (2014, ch. 232); Young et al. (2016, ds 2, ch. 274); Ristevski et al. (2018, ds 2, ch. 350); Smith et al. (in review, ds 1, ch. 356); Ősi et al. (2018, ds 1, ch. 415); Foffa et al. (2019, ch. 416).* *We follow Young et al. (2016, ds 2) in scoring thalattosuchians as state (0). Thalattosuchians lack a fourth trochanter sensu stricto, as they only have a large flattened rugose area for the muscle attachment, not a distinct process. Thus state (0) is a putative apomorphy of Thalattosuchia.* 0. absent, flattened rugose area 1. low and without a distinct medial asymmetrical apex (= fourth trochanter) 2. bladelike with a distinct asymmetric apex located medially
461	**Lateral edge of proximal articular surface of femur (lesser trochanter):** *Young & Andrade (2009, ch. 117); Young et al. (2011, ch. 117); Young et al. (2013a, ch. 187); Young et al. (2012, ch. 222); Young (2014, ch. 233); Young et al. (2016, ds 2, ch. 275); Ristevski et al. (2018, ds 2, ch. 351); Smith et al. (in review, ds 1, ch. 357); Ősi et al. (2018, ds 1, ch. 416); Foffa et al. (2019, ch. 417).* *State (1) occurs in Metasuchia.*

	0. rounded 1. 'squared' with enlarged scar for *Musculus ischiotrochantericus*
462	**Femur, medial condyle of the distal portion:** *Nesbitt (2011, ch. 320 mod.); Young et al. (2013a, ch. 188 mod.); Young et al. (2012, ch. 223 mod.); Young (2014, ch. 234 mod.); Young et al. (2016, ds 2, ch. 276 mod.); Ristevski et al. (2018, ds 2, ch. 352 mod.); Smith et al. (in review, ds 1, ch. 358); Ősi et al. (2018, ds 1, ch. 417); Foffa et al. (2019, ch. 418).* *State (0) occurs in basal pseudosuchians.* *State (1) occurs in Postosuchidae + Crocodylomorpha.* *State (2) occurs in Metriorhynchidae.* 0. tapers to a point on the medial portion in distal view 1. smoothly rounded in distal view 2. condyle incompletely ossified, and typically poorly developed
463	**Femur, distal surface between the lateral and medial condyles:** *Nesbitt (2011, ch. 321); Young et al. (2013a, ch. 189); Young et al. (2012, ch. 224); Young (2014, ch. 235); Young et al. (2016, ds 2, ch. 277); Ristevski et al. (2018, ds 2, ch. 353); Smith et al. (in review, ds 1, ch. 359); Ősi et al. (2018, ds 1, ch. 418); Foffa et al. (2019, ch. 419).* *State (1) occurs in crocodyliforms, and some 'sphenosuchians'.* *Within Crocodyliformes, state (0) is a putative apomorphy of Metriorhynchidae.* 0. nearly flat or flat 1. groove separating the medial condyle from the lateral condyle
464	**Tibia, in lateral view, angle of tibial tuberosity: (NEW)** *See Figure 19 in Johnson et al. (2017).* *State (1) occurs in Machimosaurini.* 0. angled horizontally 1. angled ventrally
465	**Calcaneum tuber, development:** *Young (2006, ch. 45 mod.); Wilkinson et al. (2008, ch. 74 mod.); Young & Andrade (2009, ch. 74 mod.); Andrade et al. (2011, ch. 466); Young et al. (2011, ch. 74 mod.); Young et al. (2013a, ch. 191 mod.); Young et al. (2012, ch. 226 mod.); Young (2014, ch. 237 mod.); Young et al. (2016, ds 2, ch. 279 - rephrased); Ristevski et al. (2018, ds 2, ch. 354); Smith et al. (in review, ds 1, ch. 360); Ősi et al. (2018, ds 1, ch. 419); Foffa et al. (2019, ch. 420).* *This character scores the regression of the tuber in metriorhynchines. Whether the calcaneal tuber regresses in geosaurine metriorhynchids is currently unknown.* 0. well developed with a long neck (typically subequal in length to main body of calcaneum) 1. poorly developed with a short neck (less than half length of calcaneum main body, and projects out in one plane from the calcaneum main body)
466	**Calcaneum, size of calcaneum tuber in relation to astragulus: (NEW)** *State (1) occurs in* Mycterosuchus nasutus. 0. subequal in size (±10%) 1. tuber much larger (at least 25%) than astragalus
467	**Pes, length of metatarsals: (ORDERED)** *Young (2006, ch. 46 mod.); Wilkinson et al. (2008, ch. 75 mod.); Young & Andrade (2009, ch. 75 mod.); Young et al. (2011, ch. 75 mod.); Young et al. (2013a, ch. 192 mod.); Young et al. (2012, ch. 227 mod.); Young (2014, ch. 238 mod.); Young et al. (2016, ds 2, ch. 280 mod.); Ristevski et al. (2018, ds 2, ch. 355 mod.); Smith et al. (in review, ds 1, ch. 361 mod.); Ősi et al. (2018, ds 1, ch. 420); Foffa et al. (2019, ch. 421).* *States (1-2) occur in Metriorhynchoidea.* *State (2) occurs in Metriorhynchidae.* *This character helps score the modification of the pes into paddles in Metriorhynchoidea.* 0. metatarsals I–IV longer than their respective digit phalanges (greater than 20%) 1. metatarsals II–IV sub-equal in length to their respective digit phalanges (± 10%)

	2. metatarsals II–IV shorter than their respective digit phalanges (less than 90%)
468	**Pes, proximal morphology of metatarsal I: (ORDERED)** *Young (2006, ch. 47 mod.); Wilkinson et al. (2008, ch. 76 mod.); Young & Andrade (2009, ch. 76 mod.); Andrade et al. (2011, ch. 467 mod.); Young et al. (2011, ch. 76 mod.); Young et al. (2013a, ch. 193 mod.); Young et al. (2012, ch. 228 mod.); Young (2014, ch. 239 mod.); Young et al. (2016, ds 2, ch. 281 mod.); Ristevski et al. (2018, ds 2, ch. 356 mod.); Smith et al. (in review, ds 1, ch. 362 mod.); Ősi et al. (2018, ds 1, ch. 421); Foffa et al. (2019, ch. 422).* *States (1-4) occur in Metriorhynchoidea.* *This character scores the broadening of metatarsal I seen in metriorhynchines. The pes of geosaurine metriorhynchid is currently unknown.* *This character helps score the modification of the pes into paddles in Metriorhynchoidea.* 0. proximal end not enlarged (typically no more than 10%, but depending on preservation up to 20%, wider than any other metatarsal) 1. proximal end enlarged (25-30% wider) 2. proximal end moderately enlarged (45-55% wider) 3. proximal end greatly enlarged (more than 75% wider)
469	**Pes, relative length of digits III and IV:** *Young (2006, ch. 48); Wilkinson et al. (2008, ch. 77); Young & Andrade (2009, ch. 77); Andrade et al. (2011, ch. 465); Young et al. (2011, ch. 77); Young et al. (2013a, ch. 194); Young et al. (2012, ch. 229); Young (2014, ch. 240); Young et al. (2016, ds 2, ch. 283); Ristevski et al. (2018, ds 2, ch. 357); Smith et al. (in review, ds 1, ch. 363); Ősi et al. (2018, ds 1, ch. 422); Foffa et al. (2019, ch. 423).* *In crocodyliforms, the digits are usually in the following descending order: III-IV-II-I. State (1) is putative apomorphy of Metriorhynchoidea, and with digit length arranged as IV-III-II-I (see Young & Andrade 2009, Appendix 2). Previously this has been considered to be a metriorhynchid apomorphy.* *This character helps score the modification of the pes into paddles in Metriorhynchoidea.* 0. digit III is longer than digit IV 1. digit IV is longer than digit III (digit IV elongated, helping to create a paddle)
470	**Pes, digit IV, number of phalanges: (ORDERED)** *Nesbitt (2011, ch. 396 mod.); Ristevski et al. (2018, ds 2, ch. 358); Smith et al. (in review, ds 1, ch. 364); Ősi et al. (2018, ds 1, ch. 423); Foffa et al. (2019, ch. 424).* *State (0) is a putative apomorphy of* Postosuchus*.* *State (1) occurs in most archosauriforms.* *State (2) is a putative apomorphy of Crocodylomorpha.* *Ristevski et al. (2018, ds 2) added state (0) as six pedal digit IV phalanges have been reported for specimens of* P. alisonae *Peyer et al. (2008) and* P. kirkpatricki *(Weinbaum, 2013).* 0. six 1. five 2. four or fewer
471	**Pes, digit V, metatarsals and phalanges:** *Clark (1994, ch. 88 mod.); Nesbitt (2011, ch. 399 re-phrased); Young et al. (2016, ds 2, ch. 282); Ristevski et al. (2018, ds 2, ch. 359); Smith et al. (in review, ds 1, ch. 365); Ősi et al. (2018, ds 1, ch. 424); Foffa et al. (2019, ch. 425).* *State (0) occurs in non-crocodylomorphs.* *State (1) occurs in 'sphenosuchians'.* *State (2) is a putative apomorphy of Crocodyliformes.* 0. present and "fully" developed first phalanx 1. present and "poorly" developed first phalanx 2. without phalanges and metatarsal tapers to a point

Dermal ossifications: osteoderms (Ch. 472 – 496; 5.091% of characters)

#	Description
472	**Ornamentation (dorsal osteoderms), type of sculpture: (*)** *Ortega et al. (2000, ch. 111); Andrade et al. (2011, ch. 19); Ristevski et al. (2018, ds 2, ch. 360); Smith et al. (in review, ds 1, ch. 366); Ősi et al. (2018, ds 1, ch. 425); Foffa et al. (2019, ch. 426).* *Ornamentation on the osteoderms is always present, and only in two possible forms. Note that Turner & Buckley (2008) considered that* Araripesuchus gomesii *and (possibly)* A. tsangatsangana *displayed the 'fleur de lys' pattern (anterolaterally and anteromedially directed "ridges"; Osmólska et al., 1997), according to the character by Pol & Norell (2004b, ch188). We consider that this pattern regards the disposition of the sculpturing (fabric), not the type of sculpturing.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. vermiform-dendritic pattern 1. pitted pattern
473	**Ornamentation (dorsal osteoderms), distribution of pits on dorsal surface: (*)** *Young et al. (2011, ch. 185 mod.); Young et al. (2013a, ch. 201 mod.); Young et al. (2012, ch. 239 mod.); Young (2014, ch. 250 mod.); Young et al. (2016, ds 2, ch. 297 mod.); Ristevski et al. (2018, ds 2, ch. 361 mod.); Smith et al. (in review, ds 1, ch. 367); Ősi et al. (2018, ds 1, ch. 426); Foffa et al. (2019, ch. 427).* *State (2) is a putative autapomorphy of* Magyarosuchus fitosi. *State (3) is a putative apomorphy of Machimosaurini*. *Ősi et al. (2018) added state (2) to accommodate the unusual osteoderm pit morphology seen in* Magyarosuchus fitosi. *This character is not applicable for taxa that lack dorsal osteoderms, or pitted ornamentation.* 0. small round to ellipsoid pits, very densely distributed 1. large round to ellipsoid pits, well separated from one another 2. irregularly shaped pits (including circular, ellipsoid, bean-shaped, triangular and quadrangular shapes), with an extreme variation in size (from small to very large), with elongate pits present on the ventrolateral surface running from the keel to the lateral margin 3. pits variable in size and length, from small to large, but on osteoderms with a keel, the pits can become elongate grooves, especially along the lateral margins
474	**Presacral osteoderms, dorsal to the vertebral column:** *Clark (1994, ch. 100 mod.); Brochu (1999, ch. 39 part); Young (2006, ch. 51); Wilkinson et al. (2008, ch. 80); Young & Andrade (2009, ch. 80); Andrade et al. (2011, ch. 468 part); Nesbitt (2011, ch. 401); Young et al. (2011, ch. 80); Young et al. (2013a, ch. 196 part); Young et al. (2012, ch. 232 part); Young (2014, ch. 243 part); Wilberg (2015b, ch. 382); Young et al. (2016, ds 2, ch. 285); Wilberg (2017, ch. 394); Ristevski et al. (2018, ds 2, ch. 362); Smith et al. (in review, ds 1, ch. 368); Ősi et al. (2018, ds 1, ch. 427); Foffa et al. (2019, ch. 428).* *State (0) occurs in* Junggarsuchus *and Metriorhynchidae.* 0. absent 1. present
475	**Presacral ventral osteoderms (= gastral osteoderms), form a carapace in the trunk region:** *Young (2006, ch. 50 mod.); Wilkinson et al. (2008, ch. 79 mod.); Young & Andrade (2009, ch. 79 mod.); Andrade et al. (2011, ch. 468 part); Nesbitt (2011, ch. 409 re-phrased); Young et al. (2011, ch. 79 mod.); Young et al. (2013a, ch. 199); Young et al. (2012, ch. 236 mod.); Young (2014, ch. 247 mod.); Young et al. (2016, ds 2, ch. 294); Ristevski et al. (2018, ds 2, ch. 374); Smith et al. (in review, ds 1, ch. 380); Ősi et al. (2018, ds 1, ch. 428); Foffa et al. (2019, ch. 429).* *Crocodyliformes have state (1), although with reversions.* 0. absent 1. present
476	**Nuchal armour, relation of nuchal osteoderms with the remaining dorsal armour and skull: (*)**

	Brochu (1999, ch. 38 mod., part); Andrade et al. (2011, ch. 469); Ristevski et al. (2018, ds 2, ch. 363); Smith et al. (in review, ds 1, ch. 369); Ősi et al. (2018, ds 1, ch. 429); Foffa et al. (2019, ch. 430). *Note that a similar character was devised by Ortega et al. (2000, ch. 109), but to unite the undescribed Itaborai form and* Sebecus*. See also McAliley et al. (2006) for discussion on eusuchians*. *This character is not applicable for taxa that lack dorsal osteoderms.* 0. large nuchal shields continuous from postoccipital region to trunk armour, with any given osteoderm contacting the anterior and posterior elements (except for the first postoccipital shield) 1. large nuchal shields continuous with trunk armour, but not reaching the postoccipital region 2. large nuchal shields discontinuous with dorsal trunk armour and absent from postoccipital region
477	**Nuchal armour, number and arrangement of nuchal shields: (*)** *Brochu (1999, ch. 38 mod. & rev. in part); Andrade et al. (2011, ch. 470); Ristevski et al. (2018, ds 2, ch. 364); Smith et al. (in review, ds 1, ch. 370); Ősi et al. (2018, ds 1, ch. 430); Foffa et al. (2019, ch. 431).* *State (3), and the terminology 'cervical shield' is according to Marinho & Carvalho (2009). See also McAliley et al. (2006) for discussion on eusuchians.* *This character is not applicable for taxa that lack dorsal osteoderms, or that lack a distinct nuchal shield (i.e. thalattosuchians).* 0. four paramedian nuchal shields, sided by two accessory shields, all enlarged relative to the remaining neck dermal armour 1. four paramedian nuchal shields enlarged relative to remaining neck shields, and no accessory shield enlarged 2. eight (or more) shields, arranged in two paramedian rows, enlarged relative to remaining neck shields, with no accessory shield enlarged 3. ten or more median osteoderms, combined with several lateral osteoderms, composing a distinct cervical shield
478	**Nuchal armour, morphology of nuchal shields relative to the remaining trunk dermal armour: (*)** *Brochu (1999, ch. 38 mod. in part); Andrade et al. (2011, ch. 471); Ristevski et al. (2018, ds 2, ch. 365); Smith et al. (in review, ds 1, ch. 371); Ősi et al. (2018, ds 1, ch. 431); Foffa et al. (2019, ch. 432).* *State (1) occurs in* Armadilosuchus *and Susisuchidae + Eusuchia (with a reversal in gavialoids).* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. nuchal and dorsal trunk shields undifferentiated, morphology grading continuously 1. nuchal shields clearly differentiated from dorsal trunk shields by size and general morphology (regardless of contact between nuchal and trunk series)
479	**Presacral dorsal armour, presence of an anterior process (= anterolateral process, = stylofoveal process) to articulate with the anterior adjacent osteoderm, in medial dorsal elements: (*)** *Norell & Clark (1990, ch. 13 rev.); Clark (1994, ch. 96 mod.); Brochu (1999, ch. 40 rev.); Ortega et al. (2000, ch. 113 rev.); Andrade et al. (2011, ch. 477 mod.); Young et al. (2011, ch. 184); Young et al. (2013a, ch. 198); Young et al. (2012, ch. 233 mod.); Young (2014, ch. 244); Young et al. (2016, ds 2, ch. 286); Ristevski et al. (2018, ds 1, ch. 483; ds 2, ch. 366 mod.); Smith et al. (in review, ds 1, ch. 372 mod.; ds 2, ch. 483 mod.); Ősi et al. (2018, ds 1, ch. 432); Foffa et al. (2019, ch. 433).* *Scores for a similar morphology as Nesbitt (2011, ch. 403).* *Note that this process does not include the lateral processes seen in dyrosaurids, as they articulate with the accessory osteoderms.* *State (2) is a putative apomorphy of* Magyarosuchus fitosi. *Ősi et al. (2018) modified this character by adding state (2), which is a modification of the distinct 'peg-like' anterolateral process seen in* Magyarosuchus fitosi.

	This character is not applicable for taxa that lack dorsal osteoderms. 0. absent 1. present, as a distinct 'peg-like' process 2. present, but as an indistinct process, no longer being distinctly 'peg-like', as their lateral margin is contiguous with that of the osteoderm ventrolateral surface
480	**Presacral dorsal armour, surface of only the paravertebral osteoderms: (*)** *Andrade et al. (2011, ch. 476); Nesbitt (2011, ch. 404); Young et al. (2012, ch. 235); Young (2014, ch. 246); Young et al. (2016, ds 2, ch. 287); Ristevski et al. (2018, ds 2, ch. 367); Smith et al. (in review, ds 1, ch. 373); Ősi et al. (2018, ds 1, ch. 433); Foffa et al. (2019, ch. 434).* *Crocodile-line archosaurs including, basal crocodylomorphs, have state (1).* *In Thalattosuchia* Teleosaurus cadomensis *and* Platysuchus multiscrobiculatus *also have state (1).* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. either weakly arched or mostly straight, forming a flat osteoderm, either keeled or not 1. osteoderm either strongly curved, with convex surface, partially embracing the vertebrae from side to side, or the curvature is restricted to a distinct bend near the lateral edge
481	**Presacral dorsal armour, biserial or tetraserial dorsal shield: (*)** *Young & Andrade (2009, ch. 147 part); Young et al. (2011, ch. 147 part); Young et al. (2013a, ch. 197 part); Young et al. (2012, ch. 232 part); Young (2014, ch. 243 part); Young et al. (2016, ds 2, ch. 289); Ristevski et al. (2018, ds 2, ch. 368); Smith et al. (in review, ds 1, ch. 374); Ősi et al. (2018, ds 1, ch. 434); Foffa et al. (2019, ch. 435).* *State (1) occurs in Susisuchidae + Eusuchia.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. biserial dorsal shield (one pair of paramedian osteoderms per row) 1. tetraserial dorsal shield (two pairs of paramedian osteoderms per row)
482	**Presacral dorsal armour, presence of accessory osteoderm columns that do not have a peg-like articulation with the paramedian column, and which are smaller in size than the paramedian column(s): (*) (ORDERED)** *Ristevski et al. (2018, ds 2, ch. 369); Smith et al. (in review, ds 1, ch. 375); Ősi et al. (2018, ds 1, ch. 435); Foffa et al. (2019, ch. 436).* *This character is an amalgam of Andrade et al. (2011, ch. 472 + 473) and Young et al. (2016, ds 2, ch. 290).* *Similar to the character in: Norell & Clark (1990, ch. 12 mod.); Brochu (1999, ch. 37 mod.); Ortega et al. (2000, ch. 107).* *This character does not consider the accessory osteoderms of dyrosaurids to be homologous (see character relating to the 'lateral process').* *This character does not consider the accessory osteoderms of notosuchians to be homologous, as their accessory osteoderms can retain the same size and shape as the paramedian column.* *State (1) occurs in Bernissartiidae, Susisuchidae, and Eusuchia.* *State (2) occurs in* Brachychampsa *and* Alligator mississippiensis. *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent (either has: two paravertebral medial columns, the gobiosuchid, or notosuchian. or dyrosaurid morphology) 1. present, a lateral accessory column on either of the paramedian columns 2. present, two lateral accessory columns on either of the paramedian columns
483	**Presacral dorsal armour, presence of accessory osteoderm column that has a peg-like articulation with the paramedian column (through a 'lateral process' derived from the anterolateral margin of the paramedian osteoderms): (*)** *Jouve et al. (2008, ch. 37 mod.); Hastings et al. (2010, ch. 82 mod.); Young et al. (2016, ds 2, ch. 291); Ristevski et al. (2018, ds 2, ch. 370); Smith et al. (in review, ds 1, ch. 376); Ősi et al. (2018, ds 1, ch. 436); Foffa et al. (2019, ch. 437).* *State (1) occurs in dyrosaurids.*

	This character was applied to test the homology of accessory osteoderms in dyrosaurids. *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent (either has: two paravertebral medial columns, the gobiosuchid or notosuchian or the advanced neosuchian morphology) 1. present, a lateral accessory column on either side of the paramedian columns, with articulations
484	**Presacral dorsal armour, presence of accessory osteoderm columns, anteriorly two lateral accessory columns which increase to four accessory columns in the trunk region: (*)** *Ristevski et al. (2018, ds 1, ch. 477); Smith et al. (in review, ds 2, ch. 477); Ősi et al. (2018, ds 1, ch. 437); Foffa et al. (2019, ch. 438).* *State (1) occurs in the derived gobiosuchids* Zaraasuchus *and* Gobiosuchus*.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent (either has: two paravertebral medial columns, only two accessory columns, or the notosuchian morphology) 1. present
485	**Presacral dorsal armour, dimensions of the thoracic osteoderms: (*)** *Clark (1994, ch. 95 mod.); Nesbitt (2011, ch. 407); Young et al. (2012, ch. 234); Young (2014, ch. 245); Young et al. (2016, ds 2, ch. 292); Wilberg (2017, ch. 395 part); Ristevski et al. (2018, ds 2, ch. 371); Smith et al. (in review, ds 1, ch. 377); Ősi et al. (2018, ds 1, ch. 438); Foffa et al. (2019, ch. 439).* *Crocodile-line archosaurs, including basal crocodylomorphs, have state (1).* *In Thalattosuchia, cervical osteoderms can be either state (0) or (1), so Young et al. (2016, ds 2) altered this character not to include the cervical osteoderms.* *Crocodyliformes have state (2).* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. square shaped, length and width approximately equal 1. longer than wide 2. wider than long
486	**Presacral dorsal armour, transverse elongation of the thoracic osteoderms: (*)** *Wilberg (2017, ch. 395 part); Ristevski et al. (2018, ds 2, ch. 372); Smith et al. (in review, ds 1, ch. 378); Ősi et al. (2018, ds 1, ch. 439); Foffa et al. (2019, ch. 440).* *State (1) occurs in goniopholidids and pholidosaurids (reversal in dyrosaurids).* *This character can only be scored for those osteoderms that overlay the thoracic vertebrae, and come from the middle region of the trunk.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. transverse width of these osteoderms is either small or sub-equal to the anteroposterior length, or only slightly wider 1. considerably wider than long, such that the transverse width is approximately three times the anteroposterior length
487	**Presacral dorsal armour, type of contact between elements in a row: (*)** *Clark (1994, ch. 98); Andrade et al. (2011, ch. 474); Ristevski et al. (2018, ds 2, ch. 373); Smith et al. (in review, ds 1, ch. 379); Ősi et al. (2018, ds 1, ch. 440); Foffa et al. (2019, ch. 441).* *State (1) occurs in crown-group Crocodylia.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. imbricated, any given anterior trunk osteoderm partially overlays its following element 1. sutured, osteoderms do not cover adjacent dermal elements, and are sutured if in contact
488	**Presacral dorsal armour, presence of an anteroposteriorly directed keel on the dorsal surface of paramedial elements: (*)** *Buscalioni et al. (1992, ch. 22); Clark (1994, ch. 101 rev., part); Brochu (1999, ch. 35); Andrade et al. (2011, ch. 478); Young et al. (2012, ch. 240 mod.); Young (2014, ch. 251 mod.); Young et al. (2016, ds 2, ch. 298 mod.); Ristevski et al. (2018, ds 2,*

	ch. 378 mod.); Smith et al. (in review, ds 1, ch. 384); Ősi et al. (2018, ds 1, ch. 441); Foffa et al. (2019, ch. 442). *State (0) occurs in* Pelagosaurus typus. *In Thalattosuchia the cervical and anterior dorsal osteoderms can have reduced keels, which can make it look as though they are absent. However, in* Pelagosaurus typus*, the anterior dorsal osteoderms lack keels, while the mid dorsal osteoderms are very poorly keeled (hard to discern from the intrepid laminae). In Thalattosuchia the sacral and anterior-mid caudal osteoderms have raised keels, which along with the ventral caudal osteoderms are the most readily identifiable.* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent on approximately half to all of the paravertebral osteoderms, or if present in the anterior half of the presacral dorsal armour hard to discern from the interpit laminae 1. present along more than half, to all, of the paravertebral osteoderms
489	**Sacral dorsal armour, length and size of keel on the dorsal surface: (*) (NEW)** *State (1) occurs in* Lemmysuchus obtusidens *and* Neosteneosaurus edwardsi. 0. elongate (stretches across the entire osteoderm) and shallow keel 1. elongate (stretches across the entire osteoderm) and pronounced keel
490	**Presacral ventral armour, presence of ventral collar scales: (*)** *Poe (1997); Brochu (1999, ch. 156); Andrade et al. (2011, ch. 479); Ristevski et al. (2018, ds 2, ch. 379); Smith et al. (in review, ds 1, ch. 385); Ősi et al. (2018, ds 1, ch. 442); Foffa et al. (2019, ch. 443).* *This character is not applicable for taxa that lack osteoderms.* 0. absent, no shield enlarged relative to other ventral scales 1. present, forming a single row of enlarged scales 2. present, forming two parallel rows of enlarged scales
491	**Presacral ventral armour, presence of paired ossifications:** *Buscalioni et al. (1992, ch. 21); Brochu (1999, ch. 39); Andrade et al. (2011, ch. 480); Ristevski et al. (2018, ds 2, ch. 380); Smith et al. (in review, ds 1, ch. 386); Ősi et al. (2018, ds 1, ch. 443); Foffa et al. (2019, ch. 444).* 0. single or absent 1. present, pairs sutured together
492	**Postsacral (= caudal) armour, distribution of dorsal tail osteoderms:** *Clark (1994, ch. 99 mod.); Young (2006, ch. 49 part); Wilkinson et al. (2008, ch. 78 part); Young & Andrade (2009, ch. 78 part); Young et al. (2011, ch. 78 part); Young et al. (2013a, ch. 200 part); Young et al. (2012, ch. 237 mod.); Young (2014, ch. 248 mod.); Young et al. (2016, ds 2, ch. 295 mod.); Ristevski et al. (2018, ds 2, ch. 375 mod.); Smith et al. (in review, ds 1, ch. 381 mod.); Ősi et al. (2018, ds 1, ch. 444); Foffa et al. (2019, ch. 445).* *Young et al. (2012) split the dorsal and ventral tail osteoderm character as* Pelagosaurus *and* Pietraroiasuchus *lack ventral tail osteoderms, but have dorsal tail osteoderms.* 0. present 1. absent
493	**Postsacral (= caudal) armour, distribution of ventral tail osteoderms:** *Young (2006, ch. 49 part); Wilkinson et al. (2008, ch. 78 part); Young & Andrade (2009, ch. 78 part); Young et al. (2011, ch. 78 part); Young et al. (2013a, ch. 200 part); Young et al. (2012, ch. 238); Young (2014, ch. 249); Young et al. (2016, ds 2, ch. 296); Ristevski et al. (2018, ds 2, ch. 376); Smith et al. (in review, ds 1, ch. 382); Ősi et al. (2018, ds 1, ch. 445); Foffa et al. (2019, ch. 446).* *State (1) is a putative apomorphy of* Pelagosaurus + *Metriorhynchidae, and also occurs in* Pietraroiasuchus. 0. present 1. absent
494	**Postsacral (= caudal) armour, distribution when present: (*)** *Clark (1994, ch. 99 mod.); Young (2006, ch. 49 part); Wilkinson et al. (2008, ch. 78 part); Young & Andrade (2009, ch. 78 part); Andrade et al. (2011, ch. 481);*

	Ristevski et al. (2018, ds 2, ch. 377); Smith et al. (in review, ds 1, ch. 383); Ősi et al. (2018, ds 1, ch. 446); Foffa et al. (2019, ch. 447). *This character is not applicable for taxa that lack caudal osteoderms.* 0. a pair of rows, covering the vertebral column 1. several rows, enclosing the tail surface
495	**Postsacral (= caudal) armour, presence of an anteroposteriorly directed keel on the dorsal surface of paramedial elements: (*)** *Clark (1994, ch. 101 rev., part); Andrade et al. (2011, ch. 482); Ristevski et al. (2018, ds 2, ch. 381); Smith et al. (in review, ds 1, ch. 387); Ősi et al. (2018, ds 1, ch. 447); Foffa et al. (2019, ch. 448).* *This character is not applicable for taxa that lack dorsal osteoderms.* 0. absent 1. present
496	**Appendicular armour, presence of osteoderms on the limbs (at least in part):** *Pol & Norell (2004b, ch. 190); Nesbitt (2011, ch. 405); Young et al. (2016, ds 2, ch. 288); Wilberg (2017, ch. 406); Ristevski et al. (2018, ds 2, ch. 382); Smith et al. (in review, ds 1, ch. 388); Ősi et al. (2018, ds 1, ch. 448); Foffa et al. (2019, ch. 449).* *Crocodyliformes have state (1), but perhaps with reversals in some clades.* *Limb osteoderms are rarely preserved, but have been mentioned for some dyrosaurids and advanced neosuchians.* 0. absent 1. present

Dermal ossifications: gastralia (Ch. 497; 0.203% of characters)

#	Description
497	**Gastralia:** *Nesbitt (2011, ch. 412); Ristevski et al. (2018, ds 2, ch. 383); Smith et al. (in review, ds 1, ch. 389); Ősi et al. (2018, ds 1, ch. 449); Foffa et al. (2019, ch. 450).* *State (0) occurs in Postosuchus, 'sphenosuchians', and* Protosuchus*.* *State (1) occurs in crocodyliforms more derived than* Protosuchus *and Gobiosuchidae.* *State (2) occurs in* Simosuchus. 0. forming extensive ventral basket with closely packed elements 1. well-separated 2. absent

Soft tissue (Ch. 498 – 502; 0.814% of characters)

[Herein soft tissue characters are only scorable for extant taxa]

#	Description
498	**Iris colour: (*)** *Brochu & Storrs (2012, ch. 182); Narváez et al. (2015, ch. 182); Ősi et al. (2018, ds 1, ch. 450); Foffa et al. (2019, ch. 451).* *State (0) occurs in* Mecistops, Crocodylus, Caiman, Melanosuchus, Gavialis *and* Alligator mississippiensis. *State (1) occurs in* Osteolaemus, Tomistoma, Paleosuchus *and* Alligator sinensis. *This character cannot be scored for fossil taxa.* *All data from Brochu & Storrs (2012) and Narváez et al. (2015).* 0. greenish/yellowish 1. brown
499	**Tongue, presence of keratinised surface: (*)** *Brochu (1999, ch. 159); Andrade et al. (2011, ch. 483); Ristevski et al. (2018, ds 2, ch. 384); Smith et al. (in review, ds 1, ch. 390); Ősi et al. (2018, ds 1, ch. 451); Foffa et al. (2019, ch. 452).* *State (1) is a putative apomorphy of Alligatoridae/Alligatoroidea.*

	This character cannot be scored for fossil taxa. *Originally based on Taplin & Grigg (1989), apud Brochu (1999).* 0. absent 1. presence
500	**Functional lingual salt glands, presence: (*)** *based on Taplin (1985); Taplin & Grigg (1989); Brochu (2007); Andrade et al. (2011, ch. 484); Ristevski et al. (2018, ds 2, ch. 385); Smith et al. (in review, ds 1, ch. 391); Ősi et al. (2018, ds 1, ch. 452); Foffa et al. (2019, ch. 453).* *State (0) is a putative apomorphy of Alligatoridae.* *This character cannot be scored for fossil taxa.* 0. absent 1. present
501	***M. caudofemoralis*, morphology: (*)** *Frey et al. (1989); Brochu (1999, ch. 160); Andrade et al. (2011, ch. 486); Brochu & Storrs (2012, ch. 37); Narváez et al. (2015, ch. 37); Ristevski et al. (2018, ds 2, ch. 387); Smith et al. (in review, ds 1, ch. 393); Ősi et al. (2018, ds 1, ch. 454); Foffa et al. (2019, ch. 454).* *State (0) occurs in* Gavialis. *State (1) is known for all other extant crocodylians.* *This character cannot be scored for fossil taxa.* 0. with single head 1. with double head (*longus* and *brevis*)
502	**Skin colour, response to environmental colour conditions: (*)** *State (0) occurs in Alligatoridae (i.e.* Caiman, Melanosuchus, Paleosuchus *and* Alligator*),* Mecistops *and* Osteolaemus*.* *State (1) occurs in the genus* Crocodylus *(i.e.* C. rhombifer, C. moreletti, C. acutus, C. intermedius, C. niloticus, C. suchus, C. siamensis, C. palustris, C. porosus, C. mindorensis, C. novaeguineae, C. johnstoni*).* *State (2) occurs in* Gavialis *and* Tomistoma*.* *This character cannot be scored for fossil taxa.* *All data from Merchant et al. (2018).* 0. no, or very little, skin colouration change 1. dorsolateral skin surfaces change to a lighter colour in a light environment 2. dorsolateral skin surfaces change to a darker colour in a lighter environment

S3) Character and OTUs breakdowns of the merged, and parent, datasets

Table (S3.1). Character break-down from the iterations of the Hastings dataset, ultimately merged into the Hastings and Young (H+Y) matrix. Hastings *et al*. (2015) utilised two datasets: 1) Hastings *et al*. (2010, 2011); and 2) adapted from Jouve *et al*. (2006). Young *et al*. (2016) utilised two datasets: 1) first iteration of a merged dataset, an updated version of the matrix of Hastings *et al*. (2015) with characters used by Young; and 2) an updated version of Young (2014) matrix.

Type of characters	Hastings *et al*. (2010, 2011, 2015, ds 1-Hastings)	Hastings *et al*. (2015, ds 2-Jouve)	Young *et al*. (2016, ds 1-Hastings)
Skull geometry & dimensions	1	3	1
Craniomandibular ornamentation	2	3	2
Cranial rostrum	17	32	19
Skull roof	11	24	21
Orbit & temporal region	7	30	7
Palate & perichoanal structures	4	27	4
Occipital	5	9	5
Braincase, basicranium & suspensorium	8	28	14
Mandibular geometry	-	2	-
Mandible	9	22	9
Dental & alveolar	17	20	22
Vertebrae & ribs	-	6	5
Pectoral girdle & forelimbs	-	11	2
Pelvic girdle & hind limbs	-	7	1
Osteoderms	1	10	8
Total character number	**82**	**234**	**120**
Total dental+craniomandibular	**81**	**200**	**104**
Total post-cranial	**1**	**34**	**16**
Dental+craniomandibular osteology %	***98.8***	***85.47***	***86.667***
Post-cranial osteology%	***1.2***	***14.53***	***13.333***

Table (S3.2). Character break-down from the major different iterations of the Young dataset, ultimately merged into the Hastings and Young (H+Y) matrix. Young *et al*. (2016) utilised two datasets: 1) first iteration of a merged dataset, an updated version of the matrix of Hastings *et al*. (2015) with characters used by Young; and 2) an updated version of Young (2014) matrix. ***** note, the analysis for Young *et al*. (2013a) is actually a precursor to the Young *et al*. (2012) paper, which ended up being published first.

Type of characters	Young (2006)	Wilkinson *et al*. (2008)	Young (2009) / Young & Andrade (2009)	Young *et al*. (2011)	Young *et al*. (2013a) *	Young *et al*. (2012)	Young *et al*. (2013b) / Young (2014)	Young *et al*. (2016, ds2-Young)
Skull geometry & dimensions	1	1	1	1	1	3	3	5
Craniomandibular ornamentation	1	1	2	2	2	2	2	2
Craniomandibular pneumaticity	-	-	2	2	2	3	3	3
Rostral neurovascular foramina	-	-	-	-	-	-	-	1
Cranial rostrum	9	11	21	22	25	29	31	35
Skull roof	5	14	33	33	31	34	34	41
Orbit & temporal region	4	7	16	16	15	19	19	22
Palate & perichoanal structures	-	3	7	10	9	13	14	15
Occipital	-	3	6	7	8	8	8	9
Braincase, basicranium & suspensorium	-	2	10	10	13	14	15	17
Mandibular geometry	-	-	-	2	2	2	2	2
Mandible	6	9	16	18	18	22	22	26
Dental & alveolar	7	9	13	20	20	26	30	43
Vertebrae & ribs	6	6	15	17	18	22	23	24
Pectoral girdle & forelimbs	5	6	9	13	14	16	16	18
Pelvic girdle & hind limbs	7	7	11	11	16	18	20	21
Osteoderms	3	3	4	6	6	9	9	14
Total character number	**54**	**82**	**166**	**190**	**201**	**240**	**251**	**298**
Total dental+craniomandibular	**33**	**60**	**127**	**143**	**147**	**175**	**183**	**221**
Total post-cranial	**21**	**22**	**39**	**47**	**54**	**65**	**68**	**77**
Dental+craniomandibular osteology %	***61.111***	***73.171***	***76.506***	***75.263***	***73.134***	***72.917***	***72.908***	***74.161***
Post-cranial osteology%	***38.889***	***26.829***	***23.494***	***24.737***	***26.866***	***27.083***	***27.092***	***25.839***

Table (S3.3). Character break-down from the different iterations of the merged Hastings + Young (H+Y) matrix.

Type of characters	Ristevski *et al*. (2018)	Ősi *et al*. (2018)	Foffa *et al*. (in press)	Sven *et al*. (in review a)	Sven *et al*. (in review b)	Current
Skull geometry & dimensions	6	10	10	10	10	10
Craniomandibular ornamentation	4	6	6	6	6	9
Internal neuroanatomy & sensory systems	1	1	1	3	3	3
Craniomandibular pneumaticity	4	4	4	4	4	4
Rostral neurovascular foramina	2	6	6	6	6	6
Cranial rostrum	53	58	58	58	58	62
Skull roof	50	52	52	52	52	54
Orbit & temporal region	27	29	29	29	29	30
Palate & perichoanal structures	19	22	22	23	23	24
Occipital	13	15	15	15	15	16
Braincase, basicranium & suspensorium	26	26	26	26	26	26
Mandibular geometry	4	8	8	8	8	8
Mandible	28	32	32	32	32	34
Dental & alveolar	52	65	67	65	65	76
Vertebrae & ribs	26	31	31	33	35	39
Pectoral girdle & forelimbs	17	23	23	23	23	24
Pelvic girdle & hind limbs	28	37	37	37	37	46
Osteoderms	23	24	24	24	24	25
Gastralia	1	1	1	1	1	1
Soft tissue	3	4	4	5	5	5
Total character number	**387**	**454**	**456**	**460**	**462**	**502**
Total dental+craniomandibular	***289***	***334***	***336***	***337***	***337***	***362***
Total post-cranial	***95***	***116***	***116***	***118***	***120***	***135***
Total soft tissue	***3***	***4***	***4***	***5***	***5***	***5***

Dental+craniomandibular osteology %	***74.677***	***73.568***	***73.684***	***73.261***	***72.944***	***72.112***
Post-cranial osteology%	***24.548***	***25.551***	***25.439***	***25.652***	***25.974***	***26.892***
Soft tissue %	***0.775***	***0.881***	***0.877***	***1.087***	***1.082***	***0.996***

Table (S3.4) Break-down of the OTUs per clade from iterations of the Hastings dataset, ultimately merged into the Hastings and Young (H+Y) matrix. Hastings *et al*. (2015) utilised two datasets: 1) matrix of Hastings *et al*. (2010, 2011); and 2) adapted from Jouve *et al*. (2006). Young *et al*. (2016) utilised two datasets: 1) first iteration of a merged dataset, an updated version of the matrix of Hastings *et al*. (2015) with characters used by Young; and 2) an updated version of Young (2014) matrix. Note, the taxonomic break-down is based on the current topology, which for some OTUs will differ from the position they had in earlier less complete analyses.

Clades of OTUs	Hastings *et al*. (2010)	Hastings *et al*. (2011)	Hastings *et al*. (2015, ds 1-Hastings)	Hastings *et al*. (2015, ds 2-Jouve)	Young *et al*. (2016, ds 1-Hastings)
Non-crocodylomorph outgroup	-	-	-	-	1
'Sphenosuchia' s. l.	-	-	-	2	2
Basal crocodyliforms	-	-	-	7	1
Notosuchia s. l.	-	-	-	15	-
Teleosauroidea	-	-	-	1	1
Basal metriorhynchoids	-	-	-	1	1
Basal metriorhynchines	-	-	-	1	1
Indet. Neosuchia	-	-	-	1	-
Atoposauridae	-	-	-	1	-
Bernissartiidae	-	-	-	1	-
Paralligatoridae	-	-	-	2	-
Hylaeochampsidae	-	-	-	1	-
Crown-Crocodylia	-	-	-	3	2
Goniopholididae	-	-	-	4	2
Pholidosauridae	3	3	3	5	8
Basal to dyrosaurids	-	-	-	-	3
Dyrosauridae	13	14	15	4	15
Total number of OTUs	**16**	**17**	**18**	**49**	**37**
Total character number	**82**	**82**	**82**	**234**	**120**
OTU # / Characters #	***5.125 : 1***	***4.824 : 1***	***4.556 : 1***	***4.776 : 1***	***3.243 : 1***

Table (S3.5). Break-down of the OTUs per clade from the major different iterations of the Young dataset, ultimately merged into the Hastings and Young (H+Y) matrix. Young *et al*. (2016) utilised two datasets: 1) first iteration of a merged dataset, an updated version of the matrix of Hastings *et al*. (2015) with characters used by Young; and 2) an updated version of Young (2014) matrix. Note, the taxonomic break-down is based on the current topology, which for some OTUs will differ from the position they had in earlier less complete analyses. ***** note, the analysis for Young *et al*. (2013a) is actually a precursor to the Young *et al*. (2012) paper, which ended up being published first.

Clades of OTUs	Young (2006)	Wilkinson *et al*. (2008)	Young (2009) / Young & Andrade (2009)	Young *et al*. (2011)	Young *et al*. (2013a) *	Young *et al*. (2012)	Young *et al*. (2013) / Young (2014)	Young *et al*. (2016, ds2-Young)
Non-crocodylomorph outgroup	-	-	1	1	1	1	1	1
'Sphenosuchia' s. l.	-	2	3	1	1	3	3	4
Basal crocodyliforms	1	1	1	1	1	1	1	1
Notosuchia s. l.	-	-	11	-	-	11	11	12
Atoposauridae	1	1	2	-	-	2	2	2
Goniopholididae	1	1	5	3	3	4	4	5
Susisuchidae	-	-	2	1	1	2	2	2
Hylaeochampsidae	-	-	-	-	-	-	-	2
Crown-Crocodylia	-	2	4	3	3	3	3	4
Pholidosauridae	-	-	6	1	1	1	1	7
Basal to dyrosaurids	-	-	-	-	-	-	-	3
Dyrosauridae	-	-	7	-	-	-	-	8
Teleosauroidea	1	1	4	1	1	9	9	12
Basal metriorhynchoids	2	2	6	6	6	6	6	6
Basal metriorhynchines	4	5	6	5	5	5	5	3
Rhacheosaurini	4	5	12	11	11	11	11	13
Basal geosaurines	3	3	5	5	5	5	5	5
Geosaurini	4	5	11	11	12	9	11	14
Total number of OTUs	**21**	**28**	**86**	**50**	**51**	**73**	**75**	**104**
Total character number	**54**	**82**	**166**	**190**	**201**	**240**	**251**	**298**

OTU # / Characters #	***2.571 : 1***	***2.929 : 1***	***1.930 : 1***	***3.800 : 1***	***3.941 : 1***	***3.288 : 1***	***3.467 : 1***	***2.865 : 1***

Table (S3.6). Break-down of the OTUs per clade from the different iterations of the merged Hastings + Young (H+Y) matrix. Note, the taxonomic break-down is based on the current topology, which for some OTUs will differ from the position they had in earlier less complete analyses.

Clades of OTUs	Ristevski *et al*. (2018)	Ősi *et al*. (2018)	Foffa *et al*. (in review)	Sven *et al*. (in review a)	Sven *et al*. (in review b)	Current
Non-crocodylomorph outgroup	1	1	1	1	1	
'Sphenosuchia' s. l.	5	5	5	5	5	
Basal crocodyliforms	5	5	5	5	5	
Notosuchia s. l.	12	12	12	12	12	
Atoposauridae	2	2	2	2	2	
Goniopholididae	8	7	7	7	7	
Bernissartiidae	2	2	2	2	2	
Susisuchidae	2	2	2	2	2	
Hylaeochampsidae	2	2	2	2	2	
Crown-Crocodylia	4	4	4	4	4	
Pholidosauridae	10	11	11	11	11	
Basal to dyrosaurids	1	2	2	2	2	
Dyrosauridae	16	17	17	17	17	
Teleosauroidea	18	18	18	18	18	
Basal metriorhynchoids	7	8	8	8	8	
Basal metriorhynchines	4	4	4	4	4	
Rhacheosaurini	14	14	14	15	17	
Basal geosaurines	5	5	5	5	5	
Geosaurini	19	19	19	19	19	
Total number of OTUs	**137**	**140**	**140**	**141**	**143**	
Total character number	**387**	**454**	**456**	**460**	**462**	**502**
OTU # / Characters #	***2.825 : 1***	***3.243 : 1***	***3.257 : 1***	***3.262 : 1***	***3.231 : 1***	

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S5) List of institutional abbreviations

AMNH, American Museum of Natural History, New York City, NY, USA
BPI, Bernard Price Institute, Johannesburg, South Africa
BRLSI, Bath Royal Literary and Scientific Institute, Bath, England, UK
BRSMG, Bristol City Museum & Art Gallery, Bristol, England, UK
BSPG, Bayerische Staatssammlung für Paläontologie und Historische Geologie, München, Germany
CAMSM, Sedgwick Museum of Earth Science, University of Cambridge, England, UK
CM, Carnegie Museum of Natural History, Pittsburgh, PA, USA
CMC, Cincinnati Museum Center, Cincinnati, OH, USA
DORCM, Dorchester County Museum, Dorchester, United Kingdom
DGM, Departamento Nacional de Produção Mineral, Rio de Janeiro, Brazil
FEF, Fundação Educacional de Fernandópolis, Fernandópolis, Brazil
FMNH, Field Museum of Natural History, Chicago, Illinois, USA
GLAHM, Hunterian Museum, Glasgow, Scotland, UK
GPIT, Paläontologishe Sammlung der Eberhard Karls Universität, Tübingen, Germany
HLMD, Hessisches Landesmuseum, Darmstadt, Germany.
IGM, Mongolian Institute of Geology, Ulaan Bataar, Mongolia
IRSNB, Institut Royal des Sciences Naturelles de Bruxelles, Belgium
IVPP, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China
IWCMS, Isle of Wight County Museums Services (Dinosaur Isle Museum and visitor attraction) Sandown, UK
LACM, Natural History Museum of Los Angeles County, Los Angeles, California, USA
LPP, Institut de paléoprimatologie, paléontologie, humaine évolution et paléoenvironnements, Université de Poitiers, France
MACN, Museo Argentino de Ciências Naturales ‘Bernardino Rivadavia’, Buenos Aires, Argentina
MANCH, Manchester Museum, Manchester, United Kingdom
MB, Museum für Naturkunde der Humboldt Universität, Berlin, Germany
MCZ, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA

ME, Musée d'Elbeuf, Elbeuf, Normandie, France
MG, Museu Geológico, Lisbon, Portugal
MHNG, Muséum d'histoire Naturelle de la Ville de Genève, Switzerland
MHNSR, Museo de Historia Natural de San Rafael, San Rafael, Argentina
MJML, Museum of Jurassic Marine Life, Kimmeridge, Dorset, England, UK
MLP, Museo de La Plata, La Plata, Argentina
MMG, Staalisches Museum für Mineralogie, Dresden, Germany.
MNHN.F, fossil collection of the Muséum national d'Histoire naturelle, Paris, France (ALG, Algiers locality; CNJ, Canjeurs locality; GDF, Gadoufaoua (Tegema Beds); INA, In Abangharit locality; MRS, Maroc Sud, i.e. Kem Kem localities; SAM, Gara Samani locality)
MNHNL, Musée national d'histoire naturelle Luxembourg, Luxemboug
MN-UFRJ, Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil
MOZ, Museo Profesor J. Olsacher, Zapala, Argentina
MPCA, Museo Provincial "Carlos Ameghino", Cipolletti, Rio Negro, Argentina
MPEF, Museo Paleontologico Egidio Feruglio, Trelew, Argentina
MPMA, Museu de Paleontologia de Monte Alto, Monte Alto, Brazil
MTM, Magyar Természettudományi Múzeum, Budapest, Hungary
MUCPv, Museo de la Universidad Nacional del Comahue, Neuquén, Argentina
NHMUK PV, vertebrate palaeontology collection of the Natural History Museum, London, England, UK (OR, old register; R, reptiles)
NMHW, Naturhistorisches Museum Wien, Vienna, Austria.
NJSM, New Jersey State Museum, Trenton, New Jersey, USA
NOTNH, Nottingham Museum of Natural History, Nottingham, UK
OMN, Musée de l'Office National Des Mines, Tunis, Tunisia
OUMNH, Oxford University Museum of Natural History, Oxford, England, UK
PETMG, Peterborough Museum & Art Gallery, Peterborough, England, UK
PRC, Palaeontological Research and Education Centre, Maha Sarakham University, Thailand.
PVL, Instituto Miguel Lillo, Tucuman, Argentina
RCL, Museu de Ciências Naturais da Pontifícia Universidade Católica de Minas Gerais, Belo Horizonte, Brazil
RMS, Royal Museum Scotland, Edinburgh, Scotland, UK
SAM, Iziko-South African Museum, Cape Town, South Africa
SMNK, Staatliches Museum für Naturkunde Karlsruhe, Germany
SMNS, Staatliches Museum für Naturkunde Stuttgart, Germany
UA, University of Antananarivo, Madagascar
UCMP, University of California Museum of Paleontology, Berkeley, California, USA
UF/IGM, University of Florida, Florida Museum of Natural History, Gainesville, Florida, USA / Museo Geológico, at the Instituto Nacional de Investigaciones en Geociencias, Minería y Quimica, Bogotá, Colombia
UFRJ-DG, Departamento de Geologia, Universidade Federal do Rio de Janeiro, Brazil

URC, IGCE-UNESP, Museu “Paulo Milton Barbosa Landim”, Instituto de Geociências e Ciências Exatas, Universidade Estadual Paulista, Rio Claro, Brazil
USNM, National Museum of Natural History, Washington DC, USA
YPM, Peabody Museum of Natural History, Yale University, New Haven, Connecticut, USA
ZPAL, Instytut Paleobiologii PAN, Warszawa, Poland

APPENDIX S2.3

TAXON SUPPLEMENTARY MATRIX FOR:

The Phylogeny of Teleosauroidea (Chapter IV)

by Michela M. Johnson[1]

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Corresponding supplementary character matrix provided in Chapter IV, of 153 taxa and 502 characters, and formatted for use in TNT 1.5. Character 1 begins from the left-most side, and subsequent characters proceed as follows in an orderly fashon. The code **ctype** indicates ordered characters.

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        0       ?       2       ?       0       ?       0       0       1       1       ?
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        1       0       2       3       0       1       0       0       0       0       0
        0       0       0       1       2       1       0       0       0       0       1
        -       0       1       -       0       0       0       -       1       1       0
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0	?	?	?	0	?	0	0	0	0	0
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0	?	?	?	?	?	?	?	?	0	?
0	0	0	1	?	0	?	?	0	0	-
-	-	?	0	1	1	1	?	?	?	?
?	?	?	0	0	0	0	0	?	?	2
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	0	?	?
1	?	1	1	?	?	?	?	0	0	0
?	?	?	0	0	0	1	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	1	1
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	?	0	0	?
?	?	?	?	?	?	?	?	?	?	?

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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	1	?	?	?	?	1	?	0
0	0	0	?	?	?	?	?	?	?	?
?	?	?	?	?	-	-	-	-	-	
Terrestrisuchus_gracilis	0	0	0	0	?	0	2	?	0	
0	0	?	?	2	?	?	?	0	?	?
?	?	?	0	?	?	0	?	?	?	?
?	?	0	0	?	0	?	?	?	?	?
?	0	0	?	?	?	?	?	?	0	?
1	?	?	?	?	0	0	1	1	?	?
0	?	0	1	0	0	0	0	0	0	0
?	0	0	2	0	0	0	1	0	1	1
0	2	3	?	?	?	?	0	0	?	?
?	0	1	?	0	0	0	0	1	1	-
0	0	-	0	0	0	-	0	0	0	0
?	0	1	0	?	?	?	0	1	1	0
?	0	0	0	0	0	0	1	0	-	?
0	0	?	?	0	0	2	3	0	0	0
?	?	0	0	0	0	0	?	?	?	0
0	0	0	?	3	?	1	1	0	?	?
?	?	1	?	?	?	2	0	2	?	0
-	?	?	?	?	0	0	0	?	0	?
?	?	-	?	?	0	0	1	?	0	0
?	0	?	0	0	?	?	0	0	0	0
?	?	?	?	0	?	?	?	0	?	?
0	0	?	?	0	?	0	?	?	?	0
?	0	0	0	0	0	0	?	0	0	0
1	0	0	0	0	?	2	1	0	2	?
?	?	?	0	?	?	?	?	0	?	0
0	?	?	0	0	?	?	0	0	-	-
-	0	0	1	1	?	?	?	?	?	?
?	?	0	0	0	?	0	?	?	1	?
?	?	?	?	?	?	?	0	?	?	?
?	?	?	?	0	2	0	?	?	?	?
?	?	?	?	?	?	0	0	?	0	?
?	?	0	0	0	1	1	0	?	?	2
3	0	2	?	?	?	?	?	?	?	?
?	0	0	0	0	?	0	0	?	?	?
0	0	0	?	?	?	0	?	?	?	?
0	?	0	0	0	0	?	?	0	?	?
?	?	0	?	0	0	?	0	1	1	?
1	?	0	1	1	0	0	0	0	0	0
?	0	?	?	?	0	0	0	0	0	0
1	0	?	?	0	0	?	0	0	0	?
0	0	0	0	?	?	0	0	-	?	?
2	2	2	0	0	0	?	1	1	?	1
0	1	0	?	0	?	0	0	0	2	1
?	?	1	0	?	?	?	?	1	0	0
?	0	1	0	0	?	?	?	?	?	?
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Junggarsuchus_sloani		0	0	0	0	?	0	2	0	0
0	0	?	?	2	?	1	0	0	0	?
?	?	?	0	?	?	0	1	1	0	0
0	0	0	0	0	0	0	1	0	0	0
?	0	0	?	0	0	0	1	0	0	0
1	2	?	0	?	0	0	1	1	0	?
0	1	?	1	0	1	0	0	0	0	0
0	0	0	0	0	0	0	1	0	1	1
0	2	2	0	0	0	0	0	0	0	?
?	0	1	2	0	0	0	0	1	1	-
0	?	-	?	?	?	-	0	0	0	0
1	0	1	0	?	?	0	?	1	1	0
?	0	?	0	0	0	?	1	0	-	1
2	0	0	0	0	?	2	3	0	0	0
0	0	1	0	0	0	0	-	-	{12}	?
0	0	0	?	1	0	1	?	?	0	0
0	?	?	?	?	?	?	?	?	?	?
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?	?	?	0	?	?	0	1	1	0	0
?	?	?	0	0	?	0	0	1	0	?
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?	?	?	?	?	1	1	0	0	0	0
0	0	0	?	0	0	0	0	0	0	0
?	2	0	0	0	?	2	3	0	1	2
0	?	?	0	0	0	?	?	0	?	0
0	1	?	0	?	?	?	0	0	2	0
0	?	0	1	1	1	?	?	?	?	?
?	?	0	0	?	0	0	?	?	?	?
?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	2	0	0	0	0	?
?	{12}	?	0	0	?	0	0	0	0	?
?	0	0	0	0	1	1	0	0	0	?
3	?	?	0	0	?	?	?	0	0	0
?	?	?	?	?	0	1	0	?	?	?
1	?	?	?	?	0	?	?	?	?	?
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1	1	0	?	1	?	0	0	0	0	?
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2	2	?	?	?	?	?	?	?	?	?
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Eopneumatosuchus_colberti		1	?	?	?	?	?	?	?	
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?	0	?	1	?	?	2	?	?	?	?
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1	2	0	0	0	1	0	2	?	?	?
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Hemiprotosuchus_leali		0	0	0	0	?	0	2	0	0
0	?	?	?	?	?	0	2	?	1	?
?	?	1	0	?	?	0	?	?	0	?
0	0	0	0	?	?	?	1	0	0	0
?	0	?	?	0	0	?	1	?	0	0
1	2	?	1	?	0	0	?	1	?	?
?	0	0	1	?	0	?	?	?	?	?
?	?	?	?	?	?	0	1	0	1	0
0	1	1	0	0	0	0	0	1	0	0
0	0	0	1	0	0	0	0	1	0	0
0	?	0	0	?	0	-	0	0	?	?
?	0	1	?	?	?	0	?	1	?	?

0	0	0	0	0	0	?	?	1	?	1
0	0	0	0	?	?	?	2	0	0	0
0	?	1	0	0	0	0	-	-	?	?
0	0	0	?	2	?	1	?	0	?	0
0	1	1	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	0	?	?	?
?	?	-	0	0	?	?	1	?	0	?
?	?	?	0	0	?	1	0	1	?	?
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?	0	0	?	0	0	0	0	0	0	0
?	0	0	?	?	?	2	{01}	0	2	?
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0	0	1	0	?	?	?	?	0	?	?
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?	?	?	?	0	?	?	?	?	?	?
?	?	?	1	?	?	?	1	1	0	0
?	0	2	0	?	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Protosuchus_richardsoni			0	0	0	0	?	0	2	0
0	1	1	?	?	0	?	0	2	1	1
?	?	0	1	?	?	2	0	1	1	0
0	0	0	0	0	0	0	?	1	0	0
0	?	0	0	?	0	0	0	1	?	0
0	1	2	?	1	?	0	0	1	1	0
?	0	0	0	1	0	0	0	0	0	0
0	0	?	0	?	0	0	0	?	?	?
?	?	?	?	0	?	0	0	?	1	1
0	0	0	0	1	0	0	0	0	2	0
0	0	2	0	0	0	0	-	0	0	0
0	0	0	1	0	?	?	1	0	1	2
0	0	0	0	0	0	0	0	1	1	0
1	0	0	0	0	1	0	2	2	0	0
0	0	0	1	0	0	0	0	-	-	2
0	0	0	0	?	2	0	1	1	0	0
0	0	1	1	0	?	?	{12}	?	2	?
0	-	?	?	?	?	0	0	0	0	?

?	?	?	?	0	?	?	?	1	1	0
1	?	?	?	?	?	0	1	0	1	?
?	?	?	?	?	?	0	?	?	?	1
?	?	?	?	?	0	?	?	0	?	0
0	0	0	0	?	0	0	0	0	0	0
0	1	0	0	0	?	?	2	5	0	2
0	0	?	?	?	?	?	?	?	0	?
0	0	?	1	?	0	?	?	0	0	-
-	-	0	0	2	1	?	?	?	?	?
?	?	?	?	0	?	0	0	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	?	?	?	0	?
1	0	0	1	0	{01}	{01}	?	?	0	?
?	?	0	0	0	?	?	?	?	?	?
?	0	-	?	0	0	?	?	?	0	0
0	?	0	0	0	0	0	0	0	?	?
?	0	0	0	?	?	?	0	?	0	0
0	0	-	0	0	0	0	-	0	0	?
?	?	?	0	?	0	0	?	0	2	0
0	1	1	0	1	1	0	0	0	0	0
0	?	0	?	?	?	0	0	0	?	0
0	0	1	?	?	1	0	?	0	?	0
?	0	0	0	0	?	?	?	1	0	0
?	1	1	1	1	0	0	?	1	1	?
1	0	1	1	?	0	?	0	0	0	2
2	?	?	1	1	0	2	0	1	1	0
0	0	0	2	0	0	1	?	?	?	0
0	1	1	1	0	-	-	-	-	-	
Protosuchus_haughtoni	0	0	0	0	?	0	2	0	0	
1	1	?	?	0	?	0	2	1	1	?
?	?	?	0	?	2	0	1	1	0	0
0	0	0	0	?	0	?	1	0	0	0
?	0	0	?	0	0	0	1	?	0	0
1	2	?	1	?	0	0	1	1	?	?
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0	2	0	0	0	0	-	0	0	0	0
0	0	1	0	?	?	1	0	1	2	0
0	0	0	0	0	0	0	1	1	0	1
0	0	0	0	1	0	2	2	0	0	0
0	0	1	0	0	0	0	-	-	2	0
0	0	0	?	2	0	1	1	0	0	0
0	?	0	0	?	?	{12}	?	2	?	0
-	?	?	?	?	?	?	0	0	0	?
?	1	-	?	?	?	0	1	1	0	1
?	?	0	0	0	0	1	0	1	0	0
?	?	0	?	?	0	0	0	0	1	0
0	?	?	0	0	1	1	0	1	0	0
0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	2	?	0	2	0

?	1	0	0	0	0	?	?	1	0	0
0	1	1	0	0	?	?	0	0	-	-
-	?	0	2	1	?	?	?	?	?	?
?	?	?	0	0	0	0	?	?	?	?
?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	0	2	0	0	?	0	1
?	0	1	0	{01}	?	0	0	0	0	?
?	0	0	0	0	1	1	0	?	?	?
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Fruitachampsa_callisoni		1	0	?	?	?	0	0	0	0
0	1	?	?	0	?	0	2	1	?	?
?	?	?	0	?	?	0	?	?	0	?
0	0	0	0	?	?	?	1	0	0	0
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?	2	?	1	?	0	0	1	1	0	?
0	0	0	1	?	?	?	0	0	0	0
?	?	1	0	0	0	0	0	0	-	-
-	0	0	-	-	-	-	0	1	1	?
?	0	0	0	0	0	0	0	1	0	0
0	?	0	0	?	0	-	0	0	?	?
?	0	1	?	?	?	0	0	1	2	0
?	0	0	0	0	0	?	?	1	?	1
0	0	0	?	?	?	?	1	0	0	0
?	?	?	0	0	0	0	-	-	2	0
0	0	0	?	3	0	1	1	?	?	0
0	1	2	?	1	?	2	0	2	?	1
0	0	?	?	?	?	?	2	0	?	0
0	?	1	?	0	0	?	1	?	?	?
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?	1	3	?	0	0	0	0	0	0	0
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0	?	?	?	?	?	3	?	?	?	?
3	?	?	?	?	?	?	?	2	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	0	?	0	0
?	0	?	?	?	?	?	0	0	?	?
?	?	?	?	?	?	?	?	?	0	?
0	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
1	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Mariliasuchus_amarali		1	4	0	0	?	0	2	?	0
0	2	?	?	0	?	0	?	0	0	?
?	0	?	0	?	2	0	1	1	0	0
0	0	0	5	0	?	?	0	0	0	?
?	?	?	?	?	?	0	1	?	0	1
1	0	?	1	?	0	0	1	0	?	?
0	1	0	1	0	0	?	0	0	0	?
?	?	?	0	0	0	0	0	0	-	-
-	0	0	-	-	-	-	0	1	1	1
0	0	0	0	3	0	0	0	2	0	0
0	1	0	0	0	0	-	?	0	0	?
0	?	?	?	?	?	0	0	0	2	0
0	0	0	0	0	0	?	?	1	0	1
1	0	0	?	?	?	?	2	0	0	0
1	1	0	0	0	0	0	-	-	2	0
0	0	?	?	?	0	1	0	0	?	?
0	?	1	?	0	-	2	0	2	?	1
0	?	?	1	-	0	0	2	?	?	1
0	?	1	1	?	1	?	1	1	0	?
?	?	?	?	?	?	0	1	1	?	0
?	?	?	0	?	1	0	0	0	1	0
0	0	?	?	?	?	?	?	?	?	?
?	1	?	?	0	0	0	1	1	0	0
2	?	?	0	0	0	2	0	0	2	0
?	0	-	-	-	?	?	?	0	?	0
0	1	0	1	0	?	1	1	?	2	?
?	?	0	3	0	?	?	?	?	?	?
?	?	?	0	-	0	1	?	?	3	?
?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	0	?	1	0	0	?	0
0	2	1	0	2	0	0	0	0	0	?
?	0	0	0	0	1	1	0	?	0	2
1	0	2	0	0	?	?	?	1	0	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	1	?	?	?	?
0	?	?	?	?	?	?	?	?	?	?

?	?	?	?	?	?	?	?	?	?	?
?	?	?	1	?	?	?	?	0	?	?
?	?	?	?	?	?	?	?	?	?	?
?	2	?	?	?	?	?	?	?	0	?
?	?	0	?	?	?	?	?	?	?	?
1	1	0	1	0	0	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	-	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Notosuchus_terrestris		1	4	0	0	?	0	2	?	0
0	2	?	?	0	?	0	2	0	0	?
?	0	1	0	?	2	0	1	1	0	0
0	0	0	5	0	?	0	0	0	0	?
?	?	?	?	?	?	0	1	?	0	1
1	0	?	1	?	0	0	1	0	?	?
0	1	0	1	0	0	0	0	0	0	0
?	1	?	1	0	0	0	1	0	0	0
0	0	1	0	0	0	0	0	1	1	1
0	0	0	0	0	0	0	0	2	0	0
0	1	0	0	0	0	-	0	0	?	0
0	?	?	?	?	?	0	0	0	0	0
0	0	0	0	0	0	?	1	1	0	1
1	?	0	?	?	?	?	2	0	0	0
0	0	?	?	?	?	?	-	-	2	?
0	0	?	?	?	0	1	0	0	?	1
0	1	1	0	1	0	2	0	2	?	1
0	0	?	1	-	0	0	2	?	0	1
0	?	1	1	?	1	?	1	1	0	1
?	?	1	?	?	0	0	1	1	?	0
?	?	?	0	0	1	0	0	0	1	0
0	0	?	?	1	1	1	?	?	?	?
1	1	?	0	0	0	0	1	1	0	0
2	?	?	0	0	0	2	1	0	2	0
?	0	-	-	-	0	?	?	0	?	0
0	1	0	1	0	0	1	1	0	2	?
?	0	0	2	0	?	?	?	?	?	?
?	?	?	0	?	0	1	?	?	3	?
?	0	?	?	?	0	?	?	?	?	?
?	?	?	?	0	?	?	0	0	?	0
0	2	?	0	2	0	0	0	0	0	?
?	0	1	0	0	1	1	0	?	0	2
1	0	2	1	?	?	?	?	1	0	0
?	?	1	?	0	?	0	?	?	?	?
0	?	?	?	?	?	1	?	0	0	?
0	?	?	?	?	?	?	?	0	?	?
?	?	?	?	?	?	?	0	?	?	0
1	1	1	1	?	0	0	0	0	?	0
?	0	?	?	?	1	0	0	?	1	1
0	2	?	?	?	?	?	1	?	?	?
?	?	?	?	?	?	?	?	?	0	?
1	1	0	1	0	0	?	?	?	?	1

1	1	1	?	?	?	?	?	?	?	?
0	-	1	?	?	?	0	?	0	0	0
0	0	?	?	?	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Adamantinasuchus_navae			0	?	?	?	?	0	2	?
0	0	2	?	?	0	?	0	?	?	?
?	?	?	?	0	?	?	0	1	1	0
0	0	0	0	5	?	?	?	1	0	0
?	?	?	?	?	0	0	0	1	?	0
1	1	0	?	1	?	0	0	1	0	?
?	0	?	0	?	0	0	?	0	0	0
?	?	?	1	1	0	0	0	0	0	-
-	-	0	0	-	-	-	-	0	1	1
?	0	0	0	0	?	?	?	0	2	?
0	0	1	0	0	0	0	-	?	?	0
?	?	?	?	?	?	?	0	0	0	?
0	0	0	0	0	0	0	?	?	1	0
?	?	?	0	?	?	?	?	2	0	0
0	1	1	0	0	0	0	0	-	-	?
0	0	0	0	?	3	0	1	0	?	?
?	0	?	?	?	?	?	?	0	?	?
?	?	?	?	?	?	?	0	2	?	?
?	?	?	1	?	?	?	?	1	?	?
?	?	?	?	?	?	?	?	1	1	?
?	?	?	?	?	?	?	?	?	?	1
?	0	0	?	?	?	?	?	?	?	?
?	?	1	?	?	0	0	0	1	1	{01}
0	2	?	?	?	?	?	2	0	0	2
?	?	?	?	0	?	?	?	?	0	0
0	0	1	?	1	0	?	?	?	?	?
?	?	?	0	3	0	?	?	?	?	?
?	?	?	?	0	-	0	0	?	?	3
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	?	1	0	0	?
0	0	2	?	0	2	?	0	0	0	0
?	?	?	0	0	0	1	1	0	?	0
2	1	0	2	0	0	?	?	?	2	1
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	0	?	?	?	?
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0	?	0	?	?	?	?	?	?	?	?
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?	1	1	?	?	?	0	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	-	-	-	-	-	
Sphagesaurus_huenei			0	{04}	0	0	?	0	2	?	0
0	2	?	?	0	?	0	?	0	?	?

?	?	?	?	?	2	0	1	1	0	0
?	0	0	5	?	?	?	1	0	0	?
?	?	?	?	0	0	0	1	?	0	1
1	0	?	1	?	0	0	1	0	?	?
0	1	0	1	0	0	0	0	0	0	0
?	?	0	1	0	0	0	0	0	-	-
-	0	0	-	-	-	-	0	1	0	0
?	0	0	0	0	0	0	0	2	0	0
0	1	0	0	0	0	-	?	?	?	?
0	0	?	?	?	?	?	?	?	?	?
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	2	0	0	0
1	1	0	0	0	0	0	-	-	?	?
0	0	0	?	3	0	1	0	?	?	1
0	1	1	0	0	-	2	0	2	?	1
0	?	4	1	-	0	0	2	?	?	1
?	?	1	1	?	?	?	?	1	?	?
?	?	?	?	?	?	?	1	1	?	?
?	?	?	?	?	1	0	0	?	1	?
?	?	?	?	?	?	?	?	?	?	?
?	1	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	0	3	0	?	?	?	?	?	?
?	?	?	?	-	0	0	?	?	3	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	?	1	?	0	?	0
0	2	0	0	2	2	0	0	0	0	?
?	1	1	0	0	1	1	0	?	0	2
1	0	2	1	1	?	?	?	2	1	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	-	-	-	-	-		
Caipirasuchus_montealtensis			0	{04}	0	0	?	0	2	?
0	0	2	?	?	0	?	0	?	1	0
?	?	?	?	0	1	2	0	1	1	0
0	0	0	0	5	?	?	?	1	0	0
?	?	?	?	?	0	0	0	1	?	0
1	1	0	?	1	?	0	0	1	0	0
?	0	1	0	1	0	0	0	0	0	0
0	0	1	0	1	0	0	0	1	0	0

0	0	0	0	0	0	0	0	0	1	0
0	?	0	0	0	0	0	0	0	2	0
0	0	1	0	0	0	0	-	0	0	0
0	0	0	1	0	?	?	0	0	0	0
0	0	0	0	0	0	0	?	?	?	?
1	1	0	0	0	1	?	2	2	0	0
0	1	1	0	0	0	0	0	-	-	2
0	0	0	0	?	3	0	1	0	0	?
1	0	1	0	0	0	-	2	0	2	?
1	0	0	4	1	-	0	0	2	?	0
1	0	?	1	1	?	1	?	1	1	0
1	?	1	?	?	?	?	?	1	1	0
0	?	0	?	?	?	1	?	?	?	1
?	?	?	?	0	?	?	?	?	?	?
0	?	1	?	?	0	0	0	1	1	?
0	2	?	0	0	?	?	2	0	0	2
0	?	0	-	-	-	0	?	?	0	0
0	0	1	?	1	0	?	?	?	?	?
?	?	?	0	?	0	1	?	?	?	?
?	?	?	0	0	?	0	0	?	?	3
?	?	0	?	?	?	0	?	0	?	?
?	0	?	?	?	0	?	1	0	0	?
0	0	2	0	0	2	2	0	0	0	0
?	?	?	1	0	0	1	1	0	?	0
2	1	0	2	1	1	?	?	0	2	1
0	0	?	?	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
?	?	?	0	0	0	0	?	?	?	?
?	?	?	?	?	?	?	?	0	?	?
?	?	?	?	?	0	0	0	0	0	0
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	?	?	?	?	?
?	0	-	1	?	?	?	?	?	?	0
0	0	0	?	?	0	1	?	?	?	?
?	?	?	?	?	-	-	-	-	-	
Baurusuchus_pachecoi		0	4	0	0	?	0	2	0	0
0	2	?	?	0	?	0	?	1	0	?
?	?	1	?	?	2	0	1	1	0	0
0	0	0	5	0	0	0	0	0	0	0
?	0	0	?	0	0	0	1	?	0	0
2	2	?	1	?	0	0	1	0	?	?
0	1	0	1	0	1	0	0	0	0	0
?	?	0	1	0	0	0	0	0	-	-
-	0	0	-	-	-	-	0	1	1	1
0	0	0	0	4	0	0	0	1	1	0
0	1	0	0	0	0	-	0	1	0	?
0	?	?	?	?	?	?	0	0	?	0
0	0	0	0	0	0	?	0	1	0	1
2	0	0	0	1	?	2	2	0	0	0

0	0	0	0	0	0	0	-	-	2	0
1	0	?	?	3	0	1	0	0	?	?
0	1	1	0	0	-	2	0	2	?	1
0	?	?	1	-	0	0	2	?	?	1
0	?	1	1	?	1	?	1	1	0	1
?	0	?	?	?	?	?	1	1	?	0
?	?	?	0	?	1	0	0	0	1	0
0	0	?	?	?	1	1	1	?	?	0
1	1	3	?	0	0	0	0	0	0	0
2	?	?	2	1	0	2	0	0	2	1
?	0	-	-	-	1	?	?	0	?	0
0	0	1	1	0	?	?	1	0	2	1
0	0	0	2	0	2	?	?	?	?	?
?	?	0	0	?	0	0	?	?	3	?
?	0	?	?	?	0	1	?	0	1	?
0	?	?	?	1	1	0	0	0	?	1
1	0	1	0	0	0	0	0	0	0	?
?	0	0	0	0	0	1	0	?	?	2
3	0	2	0	0	?	?	?	0	0	0
?	?	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	1	?	?	?	?
0	?	0	0	0	0	?	?	?	?	?
?	?	?	?	0	0	?	?	?	?	?
?	?	?	1	0	?	?	?	?	0	?
?	?	?	?	?	?	?	?	?	1	1
?	?	?	?	1	?	?	?	?	0	?
?	?	0	?	?	?	?	1	0	?	?
1	1	0	1	0	0	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	-	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Araripesuchus_patagonicus			1	0	0	0	?	0	2	0
0	0	1	?	?	0	?	0	2	0	0
?	?	?	?	1	?	2	0	?	?	?
0	0	?	0	?	?	?	?	?	0	0
?	?	?	?	?	?	?	?	?	?	?
0	0	?	?	1	?	?	?	?	1	?
?	0	0	0	1	0	0	?	0	0	0
0	?	0	0	2	0	0	0	1	0	0
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1	0	0	0	0	0	0	0	0	2	0
0	0	0	0	0	?	0	-	0	0	0
0	0	?	1	0	?	?	0	0	0	2
0	0	0	0	0	0	0	?	1	1	0
1	0	0	0	0	?	?	?	2	0	0
0	0	0	0	0	0	0	0	-	-	2
0	0	0	0	?	0	0	1	0	?	?
1	0	1	2	0	?	?	2	0	2	?
1	0	?	?	0	1	0	0	2	?	0
1	1	?	1	1	?	2	?	1	1	?
1	?	1	?	?	?	?	?	1	1	?

0	?	?	1	0	0	1	0	0	0	1
0	0	0	?	?	?	1	1	1	1	0
?	1	1	3	?	0	0	0	0	0	1
0	1	?	?	?	?	?	2	3	1	2
?	?	?	?	0	?	0	?	?	0	0
0	0	?	0	?	0	?	?	1	0	1
0	0	0	0	2	1	?	?	?	?	?
?	?	?	?	?	0	?	0	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	?
?	0	{12}	?	0	1	?	0	0	0	0
?	?	0	0	0	0	1	?	?	?	?
?	?	?	?	?	?	?	?	?	0	?
0	?	?	?	0	?	?	0	0	?	?
?	0	?	?	?	?	?	?	?	?	?
?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	1	?	0	1	0	0	0	0	0	?
0	?	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	1	1	1	1	1	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	1	1	1	0	0	2	0	?	?	0
0	0	0	2	0	0	1	?	-	0	?
?	?	?	?	?	-	-	-	-	-	
Montealtosuchus_arrudacamposi				0	0	0	0	?	0	2
0	0	0	1	?	?	0	?	0	2	0
0	?	?	?	?	1	?	2	?	1	0
0	0	0	0	0	5	?	0	0	1	0
0	0	?	0	0	0	0	0	0	1	?
0	0	2	2	?	1	?	0	0	1	1
?	?	0	0	0	?	?	2	0	0	0
0	0	?	0	2	-	0	0	0	1	0
0	0	0	0	1	0	1	0	0	0	1
1	1	0	0	0	0	0	0	0	0	2
0	0	0	0	0	0	0	0	-	0	0
0	0	0	0	1	1	?	?	0	?	0
0	0	0	0	0	0	0	0	?	1	1
1	1	0	0	0	0	?	?	?	2	0
0	0	0	0	0	0	0	0	0	-	-
2	0	1	0	0	?	3	0	1	0	?
?	?	0	1	1	?	1	0	2	0	2
?	1	0	0	?	0	1	0	0	2	?
0	1	1	?	1	1	?	2	?	1	1
0	1	?	?	0	?	?	?	0	1	1
0	0	?	?	?	0	?	1	0	0	0
1	0	0	0	?	0	?	?	?	1	?
?	0	1	1	3	?	0	0	0	0	0
1	0	2	0	0	2	0	0	2	3	1
2	1	?	?	?	0	?	1	?	?	1
0	1	1	0	0	1	0	?	1	1	1

1 0 0 0 0 1 1 1 ? ? ?
? ? ? ? 0 0 0 0 0 ? ?
2 ? ? 0 0 ? ? 0 0 ? 0
0 ? 0 0 ? ? ? 1 0 0 0
? 1 1 0 1 0 0 0 0 0 0
0 ? ? 0 0 0 0 0 1 0 ?
? 2 3 0 2 0 0 ? ? ? 0
0 0 ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? ? ? ? 1 ? ? ? ? ?
? ? ? ? ? ? ? 1 ? 0 ?
? ? ? ? ? ? ? ? ? ? ?
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? ? 1 1 ? ? ? ? ? ? ?
? ? ? ? ? ? ? ? ? ? ?
? ? 1 ? ? ? ? ? ? ? ?
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? ? ? ? ? ? - - - - -
Uberabasuchus_terrificus 0 4 0 0 ? 0 2 0
0 0 1 ? ? 0 ? 0 ? 0 0
? ? ? ? ? ? ? 0 1 0 0
0 0 0 0 5 0 0 0 1 0 0
0 ? 0 0 ? 0 0 0 1 ? 0
0 2 2 ? 1 ? 0 0 1 1 ?
? 0 0 0 ? 1 2 0 0 0 0
? ? 0 2 - 0 0 0 1 0 0
0 0 0 0 0 1 0 0 0 1 1
1 0 0 0 0 4 0 0 0 2 0
0 0 0 0 0 0 0 - 0 0 0
? 0 0 1 1 ? ? ? ? 0 1
0 0 0 0 0 0 0 ? ? 1 1
1 0 0 0 0 ? ? ? 2 0 0
0 0 0 0 0 0 0 0 - - 2
0 1 0 0 ? 3 ? 1 0 ? ?
? 0 ? 1 0 ? ? 2 0 ? ?
? 0 ? ? ? ? ? 0 2 ? ?
? ? ? ? ? ? 2 ? 1 1 0
1 ? 0 ? ? ? ? ? ? ? ?
0 ? ? ? 0 ? {12} 0 0 0 ?
0 0 0 ? ? ? ? ? ? ? ?
? 1 ? ? ? 0 0 0 0 0 2
1 2 0 0 2 0 0 2 3 1 2
1 ? ? ? 0 ? 1 ? ? 1 0
1 ? ? 0 1 0 ? ? 1 1 1
0 0 0 0 1 1 ? ? ? ? ?
? ? ? 0 0 0 0 0 ? ? 2
? ? 0 ? ? ? ? ? ? ? ?
? ? ? ? ? 1 1 0 0 0 ?
1 1 0 1 0 1 1 0 0 0 0
? ? 0 0 0 ? 0 1 0 ? ?

2	3	0	2	0	0	?	?	?	0	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	1	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	1
?	?	2	?	?	?	?	?	1	?	?
?	?	?	?	?	?	?	?	?	?	?
?	1	1	{01}	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	1	?	?	?	{01}	2	0	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	-	-	-	-	-	
cf_Hamadasuchus_rebouli			0	5	0	0	?	0	2	0
0	0	1	?	?	0	?	0	2	0	0
?	0	?	1	1	1	2	0	0	0	0
0	0	0	0	0	?	0	0	1	0	0
0	?	0	0	0	0	0	0	1	?	0
0	2	2	?	1	?	0	0	1	1	?
?	0	?	0	1	1	2	0	0	0	0
0	?	0	0	0	0	0	0	1	0	0
0	0	0	0	0	1	0	1	0	1	1
1	0	0	0	0	0	0	0	0	2	0
0	0	0	0	0	0	0	-	0	0	0
0	0	0	1	1	?	?	0	?	0	1
0	0	0	0	0	0	0	?	1	1	1
1	0	0	0	0	1	?	2	2	0	0
0	0	0	1	0	0	0	0	-	-	{12}
0	1	0	1	?	3	0	1	0	0	?
1	0	1	1	1	1	0	2	0	2	?
1	0	?	?	0	1	0	0	2	?	0
1	1	?	1	1	?	2	?	1	1	0
1	?	0	?	?	?	?	0	1	1	0
0	?	?	1	0	?	1	0	0	0	1
0	0	0	?	0	1	1	1	1	?	0
0	3	1	3	?	0	0	0	?	?	?
?	?	0	0	2	?	?	?	?	?	?
1	?	?	?	0	?	?	?	?	?	?
?	?	?	0	?	0	?	?	?	?	?
?	?	?	0	2	1	1	?	?	?	?
?	?	?	0	0	0	0	0	?	?	2
?	?	0	1	?	?	0	1	?	1	1
?	0	0	?	?	0	1	0	0	0	?
1	1	0	1	0	1	?	0	0	0	0
?	?	0	0	0	0	0	1	0	?	?
2	3	0	2	0	0	?	?	?	0	?
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?

?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	-	-	-	-	-	
Sebecus_icaeorhinus		0	5	0	0	?	?	2	0	0
0	1	?	?	0	?	0	?	0	?	?
?	?	1	1	?	2	0	0	0	0	0
0	0	?	0	?	?	?	1	0	?	?
?	?	?	?	?	?	0	?	?	0	0
2	2	?	1	?	0	0	?	1	?	?
?	0	0	1	1	2	?	0	0	0	?
?	0	?	?	0	0	0	0	0	-	-
-	0	1	-	-	-	-	0	1	1	1
0	0	0	0	?	0	0	0	2	0	0
0	0	0	0	?	0	-	0	0	0	0
?	?	1	?	?	?	?	?	0	0	0
0	0	0	0	?	?	?	1	1	1	?
?	?	0	?	?	?	?	2	0	0	0
0	0	1	0	0	0	0	-	-	{12}	0
1	0	1	?	?	?	1	0	?	?	?
0	?	1	?	?	?	2	?	?	?	?
0	?	?	?	?	?	0	2	?	0	1
?	?	1	1	?	2	?	?	?	0	1
?	?	1	?	?	0	?	1	1	?	0
?	?	?	0	0	1	0	0	0	?	0
0	0	?	?	1	1	1	?	?	?	?
2	?	?	?	?	?	?	0	0	1	1
?	?	?	?	0	0	2	?	?	?	?
?	?	?	0	?	?	?	?	?	?	1
?	?	?	1	0	?	?	1	1	?	0
0	0	0	2	0	?	?	?	?	?	?
?	?	?	?	0	?	0	?	?	2	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	2	0	0	0	?	1
1	0	1	0	0	0	0	0	0	0	?
?	0	0	0	?	0	1	0	?	?	2
3	0	2	0	0	?	?	?	0	0	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	2	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	?
?	?	0	0	?	?	0	?	?	?	?
?	?	?	?	?	0	?	1	1	?	1
1	1	1	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?

?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Mahajangasuchus_insignis			1	?	?	0	?	?	0	0
0	0	1	?	?	0	?	0	2	0	0
?	?	?	1	?	1	?	?	?	1	0
0	0	0	?	0	?	?	?	1	?	0
?	?	?	?	0	?	?	?	?	?	?
0	1	?	?	?	?	?	?	?	?	?
?	1	0	0	?	1	2	?	0	0	0
?	?	0	2	-	0	0	0	1	0	0
1	0	0	1	0	1	0	1	0	1	1
1	?	0	0	2	4	0	0	0	2	0
0	0	0	0	0	1	0	-	0	0	0
0	?	?	1	1	?	?	1	?	0	0
0	0	0	0	0	0	0	?	1	1	1
1	1	0	0	0	?	?	?	1	0	0
0	0	0	0	0	0	0	0	-	-	?
0	1	0	0	?	3	0	1	0	0	?
?	0	1	1	?	?	?	2	0	?	?
?	0	?	?	?	?	?	?	2	?	1
1	1	?	2	1	?	0	?	?	1	?
?	?	?	0	?	?	?	0	1	1	?
0	?	?	1	0	0	1	0	0	?	1
?	?	?	?	?	?	?	?	1	?	?
0	?	1	3	?	0	0	0	1	0	0
0	1	?	?	2	?	?	2	3	1	2
1	?	?	?	0	?	?	?	?	0	0
0	?	0	0	1	0	?	?	1	?	1
0	?	?	0	?	0	2	?	?	?	?
?	?	?	?	?	?	?	0	?	?	3
?	?	0	?	?	?	?	?	?	?	?
?	?	?	?	?	1	1	0	0	0	?
1	1	{01}	0	0	?	0	?	0	0	?
?	?	?	0	0	0	0	1	0	?	?
2	3	0	2	0	0	?	?	?	0	0
0	?	?	?	?	?	0	0	0	?	?
?	0	?	?	?	?	?	?	?	?	?
?	0	?	?	?	?	?	?	0	?	?
?	?	?	0	?	0	0	?	0	?	?
?	1	0	0	1	?	0	0	0	0	?
0	?	0	?	?	?	?	?	?	?	1
1	0	2	?	?	?	?	?	1	?	0
?	0	0	0	0	?	?	?	1	0	?
?	1	1	0	1	1	0	?	?	?	?
1	?	?	?	?	?	?	?	?	?	?
?	1	?	?	?	{01}	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	-	-	-	-	-	
Alligatorium_meyeri			?	?	?	?	?	0	0	0	0
0	1	?	?	0	?	0	2	?	?	?
?	?	?	?	?	?	1	1	1	0	0
0	0	1	0	?	0	0	1	0	0	?

?	0	0	?	0	0	?	1	?	0	0
2	2	?	1	?	0	?	1	1	?	?
0	0	?	1	?	1	0	0	0	0	0
0	?	0	?	0	0	?	?	?	?	?
?	?	?	?	?	?	?	0	1	1	?
0	0	0	1	0	0	0	0	2	0	0
0	?	0	0	?	0	-	0	0	0	0
2	0	0	0	?	?	0	0	1	2	0
0	0	0	0	0	0	?	1	?	?	1
0	0	0	0	?	?	?	1	0	0	0
0	0	0	0	0	0	0	-	-	1	0
1	0	0	?	2	?	1	?	?	0	1
0	1	2	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	0	0	?	0	1	0
1	0	0	0	?	?	2	0	0	2	?
?	?	?	?	?	?	?	?	0	0	0
?	0	?	?	0	?	?	1	1	?	?
?	?	0	?	?	?	?	?	?	?	?
?	?	?	0	?	?	0	?	?	?	?
?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	0	1	0	0	?	?	1
?	0	?	0	?	?	0	0	0	0	?
?	0	0	0	0	1	?	?	?	?	?
?	?	?	0	0	?	?	?	0	?	0
?	?	?	?	?	0	0	0	?	?	?
0	?	?	?	?	0	?	?	?	?	?
0	-	?	?	?	?	-	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	1	?	?	?	0	0	0	0
?	0	?	?	0	1	0	0	1	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	0	1	1	?	?	?	?	?	?	?
?	?	?	?	0	?	0	0	?	?	2
1	?	1	?	?	?	0	1	?	0	0
0	0	2	0	0	?	?	?	?	?	?
0	1	?	?	-	-	-	-	-		
Theriosuchus_pusillus		1	{12}	?	1	?	0	0	0	0
0	1	?	?	0	?	0	2	0	0	?
?	?	1	1	1	2	1	?	1	0	0
0	0	1	0	0	0	0	1	0	0	?
?	0	0	?	0	0	2	1	?	0	0
2	2	?	1	?	0	0	1	1	?	?
0	0	0	?	0	2	0	0	0	0	0
?	0	0	?	0	0	0	1	0	0	0
0	0	0	0	0	0	1	0	1	1	1
0	0	0	0	0	0	0	0	2	0	0

0	?	0	0	?	0	-	0	0	0	0
1	0	1	?	?	?	0	?	1	2	0
0	0	0	0	0	0	?	1	1	1	1
0	0	0	?	1	?	?	1	0	0	0
0	0	0	0	0	0	0	-	-	1	0
1	0	0	?	2	0	1	0	1	0	1
0	?	1	2	?	?	2	0	2	?	1
0	?	?	0	0	0	1	2	?	0	1
0	?	1	1	?	0	?	?	?	0	1
?	?	?	?	?	0	?	1	1	0	0
?	?	?	0	0	2	0	0	0	1	0
0	0	?	?	1	1	1	?	?	0	0
2	?	3	?	0	0	0	0	0	1	?
?	0	0	0	0	2	2	?	0	2	0
?	1	0	0	0	0	?	?	0	?	0
1	0	0	1	0	?	0	?	?	?	0
0	0	0	1	{12}	?	?	?	?	?	?
?	?	0	0	0	0	0	?	?	1	?
?	0	?	?	?	?	?	?	?	?	0
0	0	2	?	0	?	?	0	0	?	1
0	0	?	0	0	0	0	0	0	0	?
?	0	0	0	0	?	1	0	?	1	2
0	-	?	0	0	?	?	?	0	0	0
?	0	1	?	0	0	0	?	?	?	?
0	0	0	?	?	?	?	?	1	0	0
0	?	0	0	0	0	?	?	0	?	?
?	?	0	?	0	0	?	0	2	?	?
1	?	0	?	0	0	0	0	0	?	?
?	?	0	0	?	1	0	0	?	1	1
0	2	?	?	1	?	?	?	?	0	?
0	0	0	0	?	?	?	?	0	?	?
{01}	0	1	?	1	0	?	?	?	?	1
1	1	1	?	0	?	0	0	0	?	?
1	?	1	?	{01}	?	0	0	?	0	0
0	0	2	0	0	?	?	?	0	0	0
1	1	?	?	-	-	-	-	-		
Eutretauranosuchus_delfsi			1	1	0	1	?	0	0	0
0	0	1	?	?	0	?	0	2	0	0
?	?	?	?	?	?	2	1	?	1	0
1	0	0	1	0	?	0	?	?	?	0
?	?	?	?	?	0	0	?	1	?	0
0	2	?	?	1	?	0	1	?	1	?
?	0	0	0	1	0	2	0	1	1	0
0	0	0	0	1	0	1	0	0	0	-
0	-	0	0	-	-	-	-	0	1	1
1	0	0	0	0	0	0	0	0	2	0
0	0	0	0	0	?	0	-	0	0	0
0	0	0	0	?	?	?	0	?	0	1
0	0	0	1	0	0	0	?	1	1	1
1	0	0	0	0	1	?	2	1	0	0
0	0	0	0	0	0	0	0	-	-	1
0	1	0	0	?	?	0	1	0	1	0

1	0	1	0	2	?	?	2	0	2	?
1	0	?	?	0	1	0	?	2	0	0
1	0	?	1	1	?	0	?	1	1	0
1	?	0	0	?	?	0	0	1	1	0
0	?	?	1	?	0	2	0	0	0	1
0	0	0	?	0	1	1	1	1	?	?
0	2	1	2	?	?	?	?	0	?	1
1	0	?	?	?	?	?	2	0	0	2
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	0	?	?	1	?	?	?	?
?	?	?	0	0	?	0	0	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
1	0	?	1	0	1	1	0	?	0	0
?	?	0	?	0	?	?	?	?	?	?
?	?	?	?	?	?	?	4	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	1	?	?	?	?	?	?	?	?	?
?	?	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
?	0	0	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	-	-	-	-	-	
Amphicotylus_stovalli		1	2	1	1	?	0	0	0	0
0	1	?	?	0	?	0	2	0	0	?
?	?	?	?	?	2	1	?	?	0	1
?	1	1	0	?	0	0	1	1	0	?
?	?	0	1	1	?	?	1	?	0	0
2	?	?	1	?	0	1	?	1	?	?
0	?	0	1	0	2	0	1	1	0	0
?	?	2	-	0	?	0	0	0	-	-
-	0	0	-	-	-	-	0	1	1	1
0	0	0	0	1	0	0	0	2	0	0
0	0	0	0	?	0	-	0	0	0	0
0	?	1	?	?	?	0	?	0	0	0
0	0	1	0	0	0	?	0	1	1	1
0	0	0	?	?	?	2	1	0	0	0
0	0	0	0	0	0	0	-	-	?	0
1	0	0	?	?	?	1	0	?	0	?
0	?	?	2	1	?	2	0	?	?	?
?	?	?	?	?	?	?	2	0	0	?
?	?	?	?	?	?	?	?	1	0	1
?	1	0	?	?	0	?	1	1	0	0
?	?	?	0	0	2	0	0	0	?	0
0	0	?	?	1	1	1	1	?	0	0

2 1 ? ? ? ? ? ? ? ? ?
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? ? 0 1 0 1 ? ? ? ? ?
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Goniopholis_baryglphaeus 1 ? ? ? ? 0 0 0
0 0 1 ? ? 0 ? 0 2 0 0
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0 2 ? ? 1 ? 0 1 ? 1 ?
? 0 0 0 1 0 2 0 1 1 1
0 ? ? 0 ? 0 1 0 0 0 -
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1 0 0 0 0 1 0 0 0 1 0
? 0 ? 0 0 ? 0 - 0 0 0
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0 0 0 1 0 0 0 ? 1 1 1
1 0 0 0 0 ? ? ? 1 0 0
0 0 0 ? 1 1 ? ? - - 1
0 1 0 0 ? 3 0 1 0 1 0
1 0 ? 0 2 ? ? 2 0 ? ?
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1 ? ? 0 ? ? ? ? 1 1 ?
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0 0 0 ? ? 1 1 1 1 ? ?
0 2 1 2 ? 0 0 0 0 0 2
1 0 0 0 0 0 2 0 - - 2
? ? 1 0 0 ? 0 ? ? 0 0
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?	?	?	?	?	?	1	0	?	0	0
?	?	?	?	?	0	1	0	?	0	?
1	0	0	1	0	1	1	0	0	0	0
?	?	0	0	0	0	0	1	0	0	2
0	0	-	0	0	0	?	4	1	0	0
0	0	?	?	?	?	0	0	?	?	?
?	0	?	?	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	0	?
?	?	?	?	?	?	?	?	?	?	?
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Goniopholis_kiplingi		1	2	1	1	?	0	0	0	0
0	1	?	?	0	?	0	2	0	?	?
?	0	?	?	1	2	1	1	1	0	1
?	1	1	0	0	0	0	1	1	0	0
?	?	0	?	1	-	0	1	?	0	0
2	2	?	1	?	0	1	1	1	0	?
0	0	0	1	0	2	0	1	1	1	0
0	?	0	1	0	1	0	0	0	-	-
-	0	0	-	-	-	-	0	1	1	?
0	0	0	0	1	0	0	0	1	0	0
0	?	0	0	0	0	-	0	0	0	0
0	0	0	0	?	?	0	?	0	0	0
?	0	1	0	0	0	0	1	1	1	1
0	0	0	?	1	0	2	1	0	0	0
0	0	0	1	1	0	0	-	-	1	0
1	0	1	?	3	0	1	0	1	0	1
0	?	0	2	1	0	2	0	2	?	1
0	?	2	0	1	0	1	2	?	?	1
?	?	?	?	?	?	0	?	1	0	1
?	1	?	0	?	?	?	1	1	0	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	0
?	1	2	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	1	2	1	?	?	?	?	?
?	?	0	0	0	0	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	0	?	1
?	0	?	0	1	?	0	0	0	0	?
?	0	0	0	0	?	1	0	?	2	0
0	-	0	0	0	?	4	1	0	?	0
0	?	?	?	?	?	?	?	?	?	?

?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Goniopholis_simus		1	2	1	1	?	0	0	0	0
0	1	?	?	0	?	0	2	0	0	?
?	?	?	?	1	2	1	1	1	0	1
0	1	1	0	?	0	?	1	1	0	0
?	0	0	?	?	-	0	1	?	0	0
2	2	?	1	?	0	1	0	1	?	?
0	0	0	?	0	2	0	1	1	1	0
0	?	0	1	0	1	0	0	0	-	-
-	0	0	-	-	-	-	0	1	1	1
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	0	0	-	0	0	0	0
1	0	0	0	?	?	0	?	0	0	0
0	0	1	0	0	0	?	1	1	1	1
0	0	0	0	?	?	2	1	0	0	0
0	0	0	1	1	0	0	-	-	1	0
?	?	1	?	3	?	1	0	?	?	?
0	1	0	2	?	?	2	0	?	?	?
?	?	?	?	?	?	1	2	?	?	?
?	?	1	1	?	?	?	1	1	0	1
?	1	?	?	?	?	?	1	1	?	0
?	?	1	?	?	2	?	?	0	1	0
0	0	?	?	?	?	?	1	1	0	0
2	1	2	0	0	0	0	0	0	1	1
0	?	0	0	?	?	1	1	0	2	?
?	?	?	?	?	?	?	?	?	0	?
?	?	0	1	0	?	?	1	?	?	?
?	?	0	1	?	1	?	?	?	?	?
?	?	0	0	0	0	0	?	?	?	?
?	0	?	?	?	1	0	?	0	0	0
0	0	?	?	0	1	0	0	0	0	1
0	0	1	0	1	1	0	0	0	0	?
?	0	0	0	0	?	1	0	0	2	0
0	-	0	0	0	1	4	1	0	0	0
0	?	?	?	?	?	0	?	?	?	?
0	?	?	?	?	?	0	?	?	?	?
0	-	?	?	?	?	-	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	1	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	1	1
?	?	?	?	1	?	?	1	?	?	?

?	?	?	?	?	?	?	1	?	?	?
0	0	1	1	1	0	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
1	?	1	?	{01}	?	0	1	?	0	0
0	0	2	1	?	1	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Anteophthalmosuchus_hooleyi				1	2	1	1	?	0	0	0
0	0	1	?	?	0	?	0	2	0	0
?	?	?	?	?	?	2	1	?	1	0
1	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	1	?	?
0	?	?	?	?	?	0	1	?	1	0
?	0	0	0	1	?	2	0	1	1	1
0	0	?	0	1	0	1	0	0	0	-
-	-	0	0	-	-	-	-	0	1	1
1	0	0	0	0	3	0	0	0	1	0
0	0	0	0	0	0	0	-	0	0	0
0	0	0	0	0	?	?	0	?	0	0
0	0	0	2	1	0	0	0	1	1	1
1	0	0	0	0	1	0	2	1	0	0
0	1	0	0	1	0	0	0	-	-	1
0	0	0	0	?	2	?	1	1	?	0
1	0	1	1	2	?	?	2	0	2	?
1	?	?	?	0	1	0	1	2	0	?
1	0	?	1	1	?	0	0	1	1	0
1	?	0	?	?	?	?	?	1	1	0
0	?	?	?	0	0	2	0	0	0	?
0	0	0	?	0	?	?	?	?	?	0
0	2	1	2	?	?	?	?	0	0	2
1	0	0	0	0	0	2	0	-	-	2
0	0	1	0	0	0	1	?	?	0	?
0	0	?	?	1	?	?	?	?	?	?
?	?	?	0	?	?	1	?	?	?	?
?	?	?	0	0	?	?	0	?	?	?
0	1	0	1	1	0	1	0	?	0	0
0	0	0	?	?	?	1	0	0	0	?
1	0	?	1	0	1	1	0	0	0	0
?	?	0	0	0	?	0	1	0	0	2
0	0	-	0	0	0	?	4	1	0	0
0	0	?	?	?	?	0	0	?	?	?
?	0	?	?	?	?	?	?	?	?	0
?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	0	2	0
?	?	?	?	?	0	?	?	0	?	?
?	?	?	?	?	?	?	?	?	?	1
1	?	?	?	?	?	0	?	1	0	1
?	0	0	0	?	0	0	0	?	0	1
?	?	0	?	?	?	0	?	?	?	?
?	?	1	1	?	?	?	?	?	?	?
?	1	1	1	1	?	?	?	1	?	0
0	0	0	2	1	0	1	?	?	?	?
?	?	?	?	?	-	-	-	-	-	

Anteophthalmosuchus_epikrator	1	2	1	1	?	0	0	0	0	0
0	0	1	?	?	0	?	0	2	0	?
?	?	?	?	?	1	2	1	1	1	0
1	0	1	1	0	?	0	0	1	?	0
0	?	0	0	1	1	-	?	1	?	0
0	2	2	?	1	?	0	1	1	1	0
?	0	0	0	1	0	2	0	1	1	1
0	0	?	0	1	0	1	0	0	0	-
-	-	0	0	-	-	-	-	0	1	1
1	0	0	0	0	1	0	0	0	1	0
0	0	0	0	0	0	0	-	0	0	0
0	0	0	0	0	?	?	0	?	0	0
0	0	0	2	1	0	0	0	1	1	1
1	0	0	0	0	1	0	2	1	0	0
0	1	0	0	1	0	0	0	-	-	1
0	0	0	0	?	?	?	1	1	1	0
1	0	1	1	2	1	0	2	0	?	?
1	?	?	2	?	1	0	1	2	?	?
1	0	?	?	?	?	?	0	1	1	0
1	?	0	0	0	?	?	0	1	1	0
0	?	?	?	0	0	2	0	?	0	1
0	0	0	?	0	1	?	?	1	1	0
0	2	1	2	?	?	?	?	0	0	1
1	0	0	0	0	?	?	0	-	-	2
0	?	?	?	?	?	?	?	?	?	?
?	0	?	1	1	?	?	1	1	?	?
1	0	?	0	1	{23}	1	?	?	?	?
?	?	?	0	0	1	0	0	0	0	?
0	1	0	1	1	0	1	?	?	?	0
0	0	0	?	?	?	1	0	0	0	?
1	0	?	?	0	1	1	0	0	0	0
?	?	0	0	0	?	0	1	0	?	2
0	0	-	0	0	0	?	4	1	0	0
0	0	?	?	?	?	0	0	?	?	?
?	0	?	0	?	?	?	0	0	0	0
0	?	?	0	0	0	0	?	?	?	?
?	?	?	0	?	0	0	?	0	2	0
0	0	0	0	2	0	0	0	0	0	?
0	?	0	0	0	0	1	0	0	1	1
1	0	?	?	?	1	0	?	1	0	0
?	0	0	1	0	0	0	0	1	0	1
?	0	0	0	1	1	0	?	1	1	?
1	1	1	1	?	?	?	?	0	0	?
2	1	1	1	1	?	?	?	1	0	0
0	0	0	2	1	0	1	?	?	?	0
1	0	?	?	?	-	-	-	-	-	
Elosuchus_cherifiensis	1	2	1	1	?	1	1	0	0	
0	3	?	?	0	?	0	2	0	0	?
?	?	?	?	?	2	1	1	?	0	0
?	0	1	0	?	?	0	?	0	0	0
?	0	0	2	2	-	?	1	?	0	0
1	2	?	?	?	?	?	1	1	?	?

0	0	?	1	?	1	0	1	0	0	0
?	?	0	2	0	1	0	0	0	-	-
-	0	0	-	-	-	-	0	1	1	?
0	0	0	0	2	0	0	0	1	0	0
0	0	0	0	0	0	-	0	0	0	0
0	1	0	?	?	?	1	0	1	0	0
0	0	2	0	0	0	0	1	1	?	1
0	0	0	0	1	0	2	1	0	1	0
0	0	0	0	0	0	0	-	-	?	0
1	0	0	?	3	0	1	0	1	0	2
0	1	0	0	1	1	2	0	2	?	1
0	?	?	0	0	0	?	2	0	?	1
0	?	2	?	?	?	0	1	1	0	1
?	1	?	0	0	0	?	1	1	0	0
?	?	?	?	?	2	0	0	0	1	0
1	0	0	0	1	?	?	1	?	0	0
2	1	2	?	?	?	?	?	?	?	1
?	?	1	0	?	?	?	?	?	?	0
?	?	?	?	?	1	?	?	?	0	?
?	?	?	?	?	?	?	?	1	?	?
?	?	0	1	?	?	?	?	?	?	?
?	?	2	0	0	1	?	?	?	1	0
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0	0	0	?	?	?	?	?	?	?	?
?	?	?	0	1	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	?	?	?	0	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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1	?	?	?	?	?	?	?	?	?	?
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Elosuchus_broinae		1	2	1	1	?	1	1	0	0
0	3	?	?	0	?	0	2	0	0	?
?	?	?	?	?	2	1	1	?	0	0
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?	0	0	2	2	-	0	1	?	0	0
1	2	?	1	?	0	1	1	1	?	?
0	0	0	1	?	1	0	1	0	0	1
?	?	0	2	0	1	?	0	0	-	-
-	0	0	-	-	-	-	0	1	1	?
0	0	0	0	2	0	0	0	1	0	0
0	?	0	0	0	0	-	0	0	0	0
0	1	0	0	?	?	1	?	1	0	0

0	0	2	0	0	0	0	1	1	1	1
0	0	0	0	?	0	?	1	0	1	0
0	0	?	?	?	?	?	-	-	1	0
?	?	?	?	3	0	1	0	1	?	2
0	?	0	0	1	1	2	0	2	?	1
0	0	?	0	0	0	1	2	0	0	1
0	?	2	1	?	2	0	1	1	0	?
?	1	?	?	?	?	?	1	1	0	0
?	0	1	0	0	2	0	0	0	1	0
1	0	0	0	?	?	?	1	1	?	0
?	1	2	?	?	?	?	0	0	1	?
?	0	1	0	?	?	?	?	?	?	0
?	?	?	0	?	1	?	?	?	0	?
?	0	?	?	?	?	0	1	1	?	0
0	0	0	1	2	1	?	?	?	?	?
?	?	2	0	0	1	0	0	0	1	?
?	0	1	?	?	0	0	0	0	?	0
0	0	?	?	?	1	0	?	?	?	0
?	0	1	0	1	1	0	0	0	?	?
?	0	0	0	0	1	?	?	?	?	?
0	-	?	0	?	?	?	?	0	?	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
1	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Vectisuchus_leptognathus			1	{12}	?	1	?	0	1	0
0	0	3	?	?	0	?	0	2	?	0
?	?	?	?	?	?	2	1	?	1	0
0	-	0	1	0	?	?	?	1	?	0
?	?	?	?	?	?	?	?	?	?	0
0	1	?	?	?	?	0	1	?	1	?
?	0	0	0	1	0	1	?	1	0	0
1	?	?	0	1	0	1	0	0	0	-
-	-	0	0	-	-	-	-	0	1	1
?	0	0	0	0	2	0	0	0	1	0
0	0	?	0	0	0	0	-	0	0	0
0	?	1	0	?	?	?	1	?	1	0
0	0	0	2	?	?	0	?	0	1	?
1	0	0	0	0	?	?	?	?	0	2
1	0	0	0	0	0	0	0	-	-	1
0	?	?	0	?	?	0	1	0	?	0
2	0	?	1	?	?	?	2	0	2	?
1	0	0	?	0	1	0	1	2	?	0

1	0	?	?	1	?	0	?	1	?	0
1	?	0	?	?	?	?	?	1	1	?
0	?	?	?	0	?	2	0	0	0	1
0	?	?	0	0	?	?	?	?	?	?
0	?	1	?	?	?	?	?	0	0	1
1	?	0	1	0	1	?	2	1	0	2
?	?	?	?	0	?	1	?	?	?	?
?	?	?	0	?	?	?	?	1	1	0
?	?	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	0	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	0	0	1	0	1	1	?	0	0	0
?	?	0	0	0	?	?	?	?	?	?
?	0	?	?	0	0	?	?	?	0	0
0	?	?	?	?	?	?	?	?	?	?
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Pholidosaurus_schaumburgensis				1	0	1	1	?	1	1
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1	1	0	0	0	0	0	0	0	0	2
0	0	0	?	0	0	?	0	-	0	0
0	0	?	1	0	0	?	?	0	?	0
0	0	?	0	2	0	0	0	0	1	1
1	1	0	0	0	0	?	?	?	1	0
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1	?	1	0	0	?	1	0	1	0	?
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1	?	?	?	0	1	4	1	?	?	?
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?	0	0	-	?	0	0	0	4	?	0
0	0	?	?	?	?	?	?	0	?	?
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Pholidosaurus_sp		1	2	1	1	2	1	1	0	0
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-	0	1	0	?	0	0	1	0	0	0
?	0	0	1	1	-	0	1	1	0	0
1	2	?	1	?	0	1	0	1	?	?
0	0	0	1	0	0	0	1	0	0	1
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-	0	0	-	-	-	-	0	1	1	1
0	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	0	-	0	0	0	0
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1	0	0	?	1	0	1	0	1	0	2
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1	0	1	0	1	?	1	2	0	2	0
0	0	-	-	-	1	?	?	?	0	?
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Meridiosaurus_vallisparadisi			?	?	?	?	?	2	1	0
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Chalawan_thailandicus		1	?	?	?	?	1	0	0	1
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Sarcosuchus_hartti		?	?	?	?	?	?	?	?	1
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Sarcosuchus_imperator		1	2	1	1	?	1	0	0	1
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?	0	0	1	0	1	0	0	0	-	-
-	0	0	-	-	-	-	0	1	1	1
0	0	0	0	3	0	0	0	0	0	0
0	0	0	0	?	0	-	0	0	0	0
0	1	0	0	?	?	1	?	0	0	0
0	0	2	0	0	0	0	1	1	1	1
0	0	0	0	?	0	2	1	0	2	1
0	0	0	0	0	0	0	-	-	1	?
1	0	0	?	1	0	1	0	?	?	2
0	1	1	0	1	0	2	0	2	?	1
0	?	?	0	1	0	?	2	0	0	1
?	?	?	1	?	2	1	1	1	0	1
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1	0	3	0	?	?	1	0	0	2	0
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1	0	0	?	0	?	?	1	?	1	0
0	0	0	1	4	1	?	?	?	?	?
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0	0	2	0	1	1	0	0	0	0	?
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0	0	2	1	0	?	?	?	?	?	?
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cf_Terminonaris_robusta			1	?	?	0	?	1	1	0
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0	1	2	?	1	?	0	1	0	1	?
?	0	?	0	1	?	0	0	1	0	0
1	?	0	0	2	0	0	0	0	0	-

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0	?	0	2	0	0	0	0	1	1	1
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0	0	0	0	0	0	0	0	-	-	1
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2	0	?	1	2	?	?	2	0	2	?
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1	?	0	?	?	?	?	?	1	1	0
0	?	0	?	?	0	2	0	0	0	1
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Oceanosuchus_boecensis			1	?	1	?	?	1	1	0
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0	?	2	?	1	?	0	1	0	1	?
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-	-	0	0	-	-	-	-	0	1	1
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0	0	1	0	0	?	?	0	?	0	0
0	0	0	2	0	0	0	0	1	?	?
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1	?	0	0	0	0	0	?	1	1	0
0	?	?	1	?	?	?	0	0	0	1
0	1	0	0	0	?	?	?	1	?	0
0	?	?	?	?	0	0	0	?	0	1
?	?	0	1	0	1	?	0	-	-	2
?	?	?	?	0	0	1	?	?	?	?
?	?	?	?	?	0	1	?	?	1	?
?	?	?	0	1	2	1	?	?	?	?
?	?	?	1	0	0	3	0	0	0	1
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	1	1	0	?	?	?
?	?	?	?	0	1	1	?	0	0	0
?	?	0	0	0	?	1	1	0	?	?
0	0	-	0	0	0	?	?	0	0	0
0	0	?	1	?	?	?	0	0	?	?
?	0	0	0	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	0	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	0	0
?	0	0	0	0	?	?	?	1	0	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	?	?	?	?	?
?	1	?	1	?	?	?	0	1	?	0
0	0	0	2	1	0	?	?	?	?	?
?	?	1	?	?	-	-	-	-	-	
Pholidosaurus_purbeckensis			1	1	1	1	?	1	1	0
0	0	3	?	?	0	?	0	1	0	0
?	?	?	?	1	?	2	1	?	?	?
0	-	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	1	0
?	0	0	0	1	?	0	0	1	0	0
0	0	?	0	1	0	1	0	0	0	-
-	-	0	0	-	-	-	-	0	1	1
1	0	0	0	0	0	0	0	0	1	0
0	0	0	0	0	0	0	-	0	0	0
0	0	1	0	0	?	?	0	0	0	0
0	0	2	2	0	0	0	0	1	1	1
1	1	0	0	0	1	0	2	1	1	0
0	0	1	1	0	0	0	0	-	-	1
0	0	0	0	?	2	0	1	0	1	0
2	0	1	1	2	?	?	2	0	2	?
1	?	0	?	?	?	?	?	2	0	0
1	0	?	2	1	?	0	0	1	1	3
1	?	0	0	0	0	0	0	1	1	0

0	?	0	1	?	0	2	0	0	0	1
0	1	0	0	0	1	1	1	1	1	0
?	2	1	3	?	?	?	?	?	?	?
?	?	?	0	1	?	?	?	?	?	?
0	0	?	?	?	?	1	?	?	?	?
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?	?	0	0	0	0	1	1	0	?	?
?	0	?	?	?	?	?	?	0	?	?
0	0	0	1	?	?	?	0	?	?	?
?	0	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	0	2	?
?	?	?	?	?	0	?	0	0	0	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
?	0	0	?	?	?	?	?	?	?	?
?	0	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	1	1	1	1	?	?	0	1	?	0
0	0	0	2	1	0	1	?	?	?	?
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Fortignathus_felixi		?	?	?	?	?	{12}	?	?	0
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0	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	2	?	?	?	0	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	0	0	1	?
?	0	0	1	?	?	{12}	?	0	?	0
0	?	?	0	?	1	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	2	?
?	0	1	0	0	0	1	1	1	1	0
0	0	1	?	?	?	?	?	?	?	1
?	?	?	0	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
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Acherontisuchus_guajiraensis			?	?	?	?	?	1	1	?
0	?	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	1	?	?	?
?	0	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	0	0	0	1
?	?	?	?	1	3	?	1	?	0	2
0	?	?	?	?	?	1	?	?	?	?
?	?	?	0	1	?	?	0	2	?	2
?	?	1	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	{12}
?	?	0	?	0	?	0	?	?	?	0
0	1	1	0	?	?	?	?	?	?	?
?	?	?	?	0	?	?	0	0	0	?
?	?	0	0	0	0	1	1	0	?	?

?	?	?	?	?	?	?	4	0	?	0
0	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	1
1	?	?	?	?	?	?	?	?	?	0
?	0	0	0	?	0	0	0	1	0	?
?	0	0	?	?	1	0	?	?	1	?
1	1	1	1	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	-	-	-	-	-	
Anthracosuchus_balrogus			1	?	?	0	2	0	0	0
0	0	1	?	?	0	?	0	2	0	0
?	?	?	?	?	?	?	1	?	?	0
?	?	0	1	1	?	1	1	1	0	0
0	?	1	0	1	1	0	2	1	0	0
0	2	2	?	1	?	0	1	1	1	0
?	1	0	0	1	0	1	1	?	0	0
?	?	?	0	1	0	?	?	0	0	-
-	-	0	0	-	-	-	-	0	1	1
1	0	0	0	0	0	0	0	1	0	0
0	0	?	0	0	0	0	-	1	1	0
0	0	0	-	1	?	?	0	0	0	0
0	?	0	2	1	0	1	0	0	1	1
1	0	0	0	0	1	0	?	1	0	0
0	?	?	1	?	?	?	0	-	-	?
0	0	0	1	?	?	?	1	?	?	?
?	?	1	?	?	1	?	2	0	2	?
1	?	?	5	0	1	0	0	2	?	?
1	0	?	?	?	?	?	2	1	?	?
?	?	?	?	?	?	?	?	?	?	1
0	?	?	?	?	?	?	?	?	?	?
?	?	?	0	?	?	?	?	?	1	0
1	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	0	?	?	?
?	?	?	0	?	0	0	?	?	?	?
?	?	?	0	0	?	0	0	0	0	?
0	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	?	0	?	?	1
?	?	0	?	0	?	?	?	0	0	0
?	?	0	0	0	0	0	1	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	0	?	?	?
?	0	?	?	?	?	?	?	?	?	?
?	1	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	1	?	?	?	?	?	?	?	0	?
?	?	0	2	?	0	?	?	?	?	?
?	?	?	?	?	-	-	-	-	-	
Arambourgisuchus_khouribgaensis				1	?	?	0	?	1	1
0	0	0	1	?	?	2	?	1	0	0
?	?	?	?	?	?	?	?	1	0	0
?	0	-	0	1	0	?	?	?	1	0
?	0	?	0	1	?	0	0	0	1	?
0	0	?	2	?	1	?	0	1	0	1
?	?	1	?	0	1	?	0	1	?	0
0	?	?	?	0	2	0	0	0	0	0
-	-	-	0	0	-	-	-	-	0	1
1	?	0	0	0	1	0	0	0	1	0
0	1	0	?	1	0	0	0	-	0	0
0	0	0	0	0	0	?	?	?	?	0
1	0	?	2	2	?	0	0	1	?	?
?	1	2	1	0	0	?	0	1	1	0
0	0	0	0	0	?	?	?	?	-	-
?	0	?	?	1	?	?	?	1	?	?
0	?	?	?	0	?	?	?	{12}	0	2
?	1	?	?	?	0	0	0	?	2	1
?	1	0	?	2	?	?	?	2	?	?
3	?	?	?	0	?	?	?	?	?	?
1	0	?	0	?	0	0	2	0	?	0
?	1	1	1	?	0	?	?	?	?	?
?	1	?	?	?	?	?	?	?	?	0
?	?	?	0	0	0	?	?	?	?	?
?	0	?	?	?	0	?	?	?	?	?
?	?	?	0	?	?	?	?	?	?	?
?	?	?	?	0	2	1	0	?	?	?
?	?	?	?	0	0	1	0	0	?	?
?	?	?	0	?	?	?	?	1	1	1
1	?	1	?	?	?	?	?	0	?	?
?	?	?	?	?	0	1	?	0	0	?
?	?	?	?	?	?	?	1	1	0	?
?	0	0	-	0	?	?	?	?	?	?
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Atlantosuchus_coupatezi 1 ? ? 0 ? 1 1 0
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Cerrejonisuchus_improcerus 1 ? 1 0 ? 0 1 0
0 0 1 ? ? 0 ? 0 2 0 ?
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0	?	1	0	1	1	0	1	1	?	0
0	?	2	?	1	?	0	1	1	1	?
?	1	0	0	?	?	1	2	?	0	0
?	0	?	0	-	0	0	0	0	0	-
-	-	0	0	-	-	-	-	0	1	1
?	0	0	0	0	0	0	0	1	0	0
0	0	?	0	0	0	0	-	0	0	0
0	0	0	-	1	?	?	0	0	1	2
0	0	0	2	1	0	0	0	0	?	?
1	0	0	0	0	1	0	1	1	?	0
0	0	0	1	?	?	?	?	-	-	?
0	?	?	0	?	?	0	1	?	?	0
?	?	?	?	?	?	?	{12}	0	2	?
1	?	?	?	0	0	0	?	2	?	?
?	?	?	?	?	?	?	2	1	?	3
?	?	?	?	0	0	0	?	1	1	1
?	?	0	?	?	?	?	?	?	?	?
1	?	1	0	?	?	?	?	?	?	?
1	?	?	?	?	?	?	0	0	0	1
?	?	0	0	1	?	?	?	?	?	?
0	?	?	?	?	?	1	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	1	0	0	?	?	?	?
?	?	?	0	0	1	0	0	?	?	3
?	?	0	?	?	?	0	1	1	1	1
?	1	1	?	?	?	1	?	?	?	?
1	?	0	1	0	1	?	?	?	?	0
?	?	0	0	0	?	?	1	0	?	0
?	?	?	?	?	?	?	?	?	?	?
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Chenanisuchus_lateroculi			1	?	1	0	?	0	1	0
0	0	1	?	?	0	?	0	2	?	?
?	?	?	?	?	?	?	1	?	?	0
0	?	0	1	0	?	?	1	1	0	0
0	?	1	0	?	?	?	1	1	?	0
0	?	2	?	1	?	0	1	1	1	?
?	1	?	0	1	?	0	?	1	0	0
0	?	?	0	1	0	0	0	0	0	-
-	-	0	0	-	-	-	-	0	1	1
1	0	0	0	0	0	0	0	1	0	0

0	0	0	1	0	?	0	-	0	0	0
0	0	1	0	0	?	?	0	?	0	0
0	0	2	2	0	0	0	0	0	1	1
1	1	0	0	0	?	0	1	1	0	0
0	0	0	0	0	0	0	0	-	-	?
0	?	?	0	?	1	0	?	0	?	0
?	?	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	2	1	?	3
1	?	0	?	?	?	?	?	1	1	1
0	?	0	?	?	?	?	?	?	0	?
1	1	?	?	0	?	?	?	1	?	0
1	?	1	3	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	2	?
?	?	1	0	?	1	?	?	?	?	?
?	?	?	?	0	?	?	0	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	0	1	?	?	?	?
?	?	?	?	0	1	?	0	0	?	?
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Congosaurus_bequaerti		1	?	?	?	?	1	1	0	0
0	2	?	?	2	?	?	?	0	?	?
?	?	?	?	?	?	1	0	0	0	0
-	0	1	0	?	1	0	1	0	0	0
?	0	1	1	1	0	1	1	0	0	0
1	2	?	1	?	0	1	0	1	0	?
1	0	?	1	0	0	?	?	0	0	?
?	?	0	2	0	0	?	0	?	?	-
-	0	0	?	-	-	-	0	1	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	0	?	?	?	?	0	0	0
?	?	1	0	?	?	?	?	?	?	?
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?	0	1	?	?	?	?	?	?	?	?

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0	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	0	0	0	1	1
?	0	?	?	?	?	1	0	0	2	?
0	0	-	-	-	1	?	?	?	0	?
?	?	0	1	2	0	0	?	2	?	?
1	1	?	2	1	0	?	?	?	?	?
?	?	0	0	1	0	0	0	0	?	0
0	?	?	?	?	?	?	?	?	?	?
1	1	0	?	0	1	0	?	?	0	1
0	0	1	0	1	1	?	0	0	0	?
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0	?	?	0	0	?	4	0	0	0	0
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0	0	0	?	0	?	0	?	0	0	?
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?	?	?	?	?	?	?	0	2	0	0
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?	0	?	?	0	?	0	?	?	1	1
0	2	?	?	1	0	?	1	0	0	?
0	0	0	?	0	0	?	1	?	?	?
0	0	?	2	1	0	?	1	1	?	1
1	1	1	?	?	?	?	?	?	?	2
1	1	?	1	?	?	?	0	0	0	0
1	0	2	0	0	?	?	?	?	0	?
?	?	?	?	-	-	-	-	-		
Dyrosaurus_maghribensis			1	5	1	0	?	1	1	0
0	0	1	?	?	0	?	0	1	0	0
?	?	?	?	?	?	2	1	0	0	0
0	-	0	1	0	?	?	?	1	0	0
0	?	0	1	?	0	0	0	1	?	0
0	?	2	?	1	?	0	1	0	1	?
?	1	0	0	1	?	0	1	?	0	0
?	?	?	0	0	0	0	0	0	0	-
-	-	0	0	-	-	-	-	0	1	1
1	0	0	0	0	0	0	0	1	0	0
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0	0	0	0	0	?	?	0	?	1	2
0	0	2	2	1	0	0	0	0	1	1
1	2	0	0	0	?	0	0	1	0	0
0	0	0	0	0	0	0	0	-	-	1
0	1	0	0	?	1	?	1	0	?	0
2	0	1	0	?	1	0	2	0	2	?
1	0	?	?	0	0	0	1	2	1	0
1	0	?	2	1	?	?	2	1	1	3
1	?	0	?	?	?	?	?	1	1	1
0	?	1	?	0	0	2	0	1	0	?
1	1	1	?	0	?	?	?	1	?	?

1	?	1	3	?	?	?	0	0	0	1
1	1	0	0	0	?	?	1	0	0	2
0	?	?	?	0	?	1	?	?	0	1
0	?	?	0	1	2	0	?	1	2	2
?	?	1	0	2	3	0	?	?	?	?
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?	0	0	?	?	?	0	1	1	1	?
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1	0	0	0	0	1	1	0	0	0	0
?	?	0	0	0	?	?	1	0	?	0
0	0	-	0	0	0	?	?	?	0	0
0	?	0	1	?	0	0	0	0	?	?
?	?	0	0	?	?	0	0	?	0	0
0	1	?	0	0	0	0	?	?	?	?
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0	?	0	?	?	?	1	0	0	1	1
1	0	2	?	?	1	0	?	1	0	0
?	0	0	0	0	?	?	0	1	0	0
?	0	0	?	?	1	0	?	1	1	?
1	1	1	1	?	?	?	0	0	0	?
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0	1	0	?	0	?	?	?	?	?	?
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Dyrosaurus_phosphaticus			1	?	?	0	?	1	1	0
0	0	1	?	?	0	?	0	2	0	?
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0	?	0	1	?	0	0	1	1	?	0
0	?	2	?	1	?	0	1	0	1	?
?	1	0	0	1	?	0	1	1	0	0
0	?	?	0	0	0	0	?	0	0	-
-	-	0	0	-	-	-	-	0	1	1
1	0	0	0	0	0	0	0	1	0	0
1	0	0	1	0	?	0	-	0	0	0
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0	0	2	2	1	0	0	0	0	1	1
1	2	0	0	0	1	0	0	1	0	0
0	0	0	0	0	0	0	0	-	-	?
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2	0	1	0	?	?	?	2	0	2	?
1	0	0	?	0	0	0	1	2	1	0
1	0	?	2	?	?	2	2	1	?	3
1	?	0	?	0	0	0	0	?	?	1
0	?	1	1	0	0	2	0	1	0	1
1	1	1	1	0	?	1	1	1	?	?
1	?	1	3	?	?	?	0	0	0	1
?	?	0	0	0	?	?	?	?	?	?
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0	?	?	?	?	?	?	0	?	?	?
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0	1	0	?	?	?	?	?	?	?	?
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Guarinisuchus_munizi		1	5	1	0	?	1	1	0	0
0	0	?	?	0	?	1	1	0	0	?
?	?	?	?	?	2	1	0	0	0	0
-	0	1	0	0	1	0	1	0	0	0
?	0	1	?	0	0	?	?	?	0	0
?	2	?	1	?	0	1	0	1	?	?
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-	0	0	-	-	-	-	0	1	1	?
0	0	0	1	0	0	0	1	0	0	1
0	0	1	0	0	0	-	0	0	0	0
0	0	0	0	?	?	?	?	0	1	0
0	0	2	1	0	0	1	0	?	?	1
2	1	0	1	?	0	?	1	0	0	0
0	0	0	0	0	0	0	-	-	?	0
?	?	0	?	0	?	1	0	?	?	?
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0	0	?	0	0	0	1	2	1	?	?
0	?	2	1	?	2	2	1	1	3	1
?	0	?	?	?	?	?	1	1	1	0
?	?	?	0	0	1	0	?	0	1	?
1	1	?	1	?	?	?	1	?	0	1
?	1	?	?	?	?	0	0	?	?	?
1	0	0	0	?	?	?	?	?	?	0
?	?	?	0	?	?	?	?	?	?	?
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?	?	0	2	1	0	?	?	?	?	?
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0	0	1	0	1	1	0	0	0	?	?
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0	-	0	0	0	?	?	?	0	0	0
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Hyposaurus_rogersii		1	5	1	0	1	1	1	0	0
0	1	?	?	0	?	1	2	?	?	?
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?	0	1	0	?	?	0	1	0	?	0
?	0	1	?	1	0	0	1	?	0	0
1	2	?	1	?	1	1	0	1	0	?
1	0	0	1	?	0	?	?	0	0	?
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-	0	0	?	-	-	-	?	1	1	1
0	0	0	0	0	0	0	1	0	0	1
0	0	1	0	?	?	-	?	?	?	?
0	0	1	0	?	?	?	0	0	2	0
?	0	2	1	0	0	0	0	1	1	1
2	0	0	1	1	0	?	1	0	0	0
?	0	0	0	0	?	?	-	-	?	?
0	0	?	?	1	?	1	0	1	0	2
0	?	0	0	?	?	?	?	2	?	1
?	?	?	?	?	?	?	2	1	?	?
?	?	?	?	?	?	2	1	?	3	1
?	0	0	0	0	0	0	1	1	1	?
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?	1	3	0	?	?	0	0	?	?	?
?	?	0	0	3	?	2	?	?	?	?
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?	?	?	?	2	0	?	?	2	?	?
0	1	0	2	1	0	?	?	?	?	?
?	?	0	0	?	0	0	?	?	3	0
?	0	1	0	0	0	1	1	1	?	0
1	1	?	?	?	?	0	0	?	0	?
?	?	?	0	1	?	?	0	?	0	?
?	0	0	0	?	1	1	?	?	0	?
?	?	?	?	?	?	?	?	0	?	?
?	?	?	?	?	0	0	0	?	?	?
0	?	?	?	?	?	?	?	?	?	?
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1	?	?	?	?	?	0	0	0	0	?
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1	1	?	?	?	?	?	0	?	?	?
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Phosphatosaurus_gavialoides			?	?	?	?	1	1	0	0
0	0	?	?	?	?	?	1	2	?	?
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?	?	0	1	0	?	1	1	1	0	?
0	?	1	0	1	1	0	1	1	0	0
0	1	2	?	1	?	0	1	1	1	0
?	1	0	?	1	?	1	1	?	?	?
?	?	?	?	?	0	?	?	0	?	-
-	-	0	0	-	-	-	-	?	1	1
1	?	0	0	?	?	?	0	1	0	0
0	0	?	1	0	0	0	?	0	0	?
?	0	?	0	0	?	?	?	0	0	1
0	?	?	?	?	0	0	0	1	?	?
?	?	?	0	0	?	0	?	1	0	0
0	?	?	0	?	?	?	?	-	-	?
0	0	?	0	?	1	?	1	?	?	?
?	?	?	0	?	?	?	?	?	2	?
1	?	?	3	0	0	0	?	2	1	?
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?	?	?	?	2	1	0	?	?	?	?
?	?	?	0	0	1	0	0	0	0	?
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0	1	0	1	?	?	?	?	?	?	?
1	?	0	1	0	?	?	?	?	?	?
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?	?	?	?	?	?	?	4	?	?	?
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Rhabdognathus_keiniensis			1	?	?	0	2	1	1	0
0	0	0	?	?	0	?	1	1	?	?
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?	1	0	0	1	?	0	?	?	0	0
?	?	?	?	?	0	?	?	0	?	-
-	-	0	0	-	-	-	-	?	1	1
1	0	0	0	0	0	0	0	1	0	0
1	0	0	1	0	0	0	-	0	0	0
0	0	0	1	0	?	?	0	0	0	2
1	?	2	2	1	0	1	1	0	1	?
1	2	1	0	1	1	1	1	1	0	0
0	0	?	?	0	0	?	?	-	-	?
?	?	?	1	?	0	?	1	0	?	?
?	?	?	?	0	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	2	1	1	3
1	?	0	0	0	0	0	0	1	1	1
0	0	0	?	?	?	?	?	?	0	1
1	1	1	?	1	?	?	1	?	1	0
1	?	1	3	0	?	?	?	?	?	?
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0	0	?	0	1	0	0	0	0	?	-
-	-	0	0	-	-	-	-	?	1	1
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1	0	0	1	0	0	0	-	0	0	0
0	0	0	1	0	?	?	0	0	0	2
0	?	0	2	1	0	1	1	0	1	1
1	2	1	0	1	1	1	1	1	0	0
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0	0	0	0	?	0	1	1	0	1	0
2	0	1	0	?	?	?	2	0	2	?
1	?	?	?	0	0	0	1	2	1	1
1	0	0	2	?	0	2	2	1	1	3
1	?	0	1	0	0	0	0	1	1	1
0	0	?	?	0	0	2	0	1	0	1
1	1	1	1	1	?	1	1	1	1	0
1	?	1	3	0	?	?	?	?	?	?
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Sabinosuchus_coahuilensis			?	?	?	?	0	1	?	0
0	0	0	?	?	2	?	?	?	?	?
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0	?	?	?	?	?	?	?	?	1	?
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1	?	?	?	?	?	?	0	2	?	?
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?	?	?	?	?	?	?	0	0	0	1
1	1	0	0	?	1	3	0	-	-	2
0	?	0	-	-	-	1	?	?	?	0
?	?	?	0	1	2	0	0	1	0	?
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?	?	0	1	0	0	0	2	?	1	0
0	1	1	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	0	0	0	0
?	?	0	0	0	0	?	?	?	?	?
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Sokotosuchus_ianwilsoni			?	?	?	?	2	1	0	0
0	0	1	?	?	1	?	1	2	0	?
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0	1	2	?	1	?	0	1	1	?	?
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0	0	?	1	0	0	0	-	?	?	?
?	0	?	?	?	?	?	?	0	0	2
0	?	?	2	0	?	?	0	1	?	?
1	1	0	0	0	?	0	?	1	0	0
0	?	0	?	?	?	?	?	?	?	?
?	?	?	?	?	1	?	1	0	1	0
2	?	?	?	?	?	?	?	0	2	?
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Bernissartia_fagesii		1	1	0	1	?	0	0	0	0
0	1	?	?	?	?	0	2	0	0	?
?	?	?	?	1	2	1	?	?	0	0
?	0	0	0	?	?	0	1	0	0	0
?	?	0	?	0	0	?	1	?	0	0
2	2	?	1	?	0	0	1	1	?	?
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-	0	0	-	-	-	-	0	1	1	?
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0	0	?	?	?	?	?	?	1	2	0
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?	?	?	?	2	?	1	?	?	0	?
0	?	?	?	?	?	2	0	2	?	1
0	?	?	?	?	?	?	2	?	?	1
0	?	2	1	?	?	?	1	1	0	?
?	?	?	?	?	?	0	1	1	?	?
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?	1	?	?	0	0	0	0	0	1	1
1	0	0	0	0	3	0	-	-	2	0

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?	?	0	1	1	1	?	?	?	?	?
?	?	0	0	0	0	0	?	?	2	?
?	0	?	?	?	?	?	?	?	0	0
?	?	?	?	?	1	?	?	0	0	1
0	0	1	0	1	1	0	0	0	1	?
?	0	0	0	0	?	0	-	0	-	-
0	-	0	0	0	?	?	?	0	0	0
0	?	?	?	?	0	0	?	?	?	?
0	?	?	?	?	?	0	?	1	2	?
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?	0	0	0	?	?	?	?	?	1	1
0	2	?	?	1	?	?	1	0	?	?
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0	0	1	1	1	0	?	?	?	?	?
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1	?	1	1	1	2	0	0	?	0	1
0	0	2	0	0	1	?	?	0	?	1
0	1	?	?	-	-	-	-	-		
Koumpiodontosuchus_aprosdokiti				1	1	0	?	?	0	0
0	0	0	1	?	?	1	?	0	2	0
0	?	?	?	?	?	?	2	1	1	1
0	0	?	0	0	0	0	?	?	1	0
?	?	?	?	?	?	0	0	0	1	0
0	0	?	?	?	1	?	0	1	?	1
0	?	0	0	0	0	0	2	0	0	0
0	0	0	?	0	?	0	0	0	0	0
-	-	-	0	0	-	-	-	-	0	1
1	1	0	0	0	0	0	0	0	0	2
0	0	0	1	0	0	0	0	-	0	0
0	0	0	0	1	1	?	?	?	?	1
2	0	0	0	0	0	0	0	?	1	1
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0	1	0	?	1	?	?	?	?	?	2
?	1	0	0	?	0	1	0	1	2	0
?	?	?	?	2	1	?	?	?	1	1
0	1	?	0	0	0	0	0	?	?	?
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1	?	?	?	?	0	?	?	?	1	?
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1	1	1	0	0	0	0	3	0	-	-
2	0	0	?	?	?	?	1	?	?	0
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Susisuchus_anatoceps		1	1	0	1	?	0	0	0	0
0	1	?	?	0	?	0	2	?	?	?
?	?	?	?	?	?	1	?	1	0	0
-	0	1	4	0	?	?	1	0	0	?
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1	2	?	1	?	0	1	?	1	?	?
?	0	0	?	?	0	?	0	0	0	0
?	?	2	-	0	0	0	0	0	-	-
-	0	0	-	-	-	-	0	1	1	1
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Isisfordia_duncani		1	1	0	1	?	0	0	0	0
0	1	?	?	0	?	0	2	0	0	?
?	?	?	?	?	2	?	?	?	0	?
-	0	1	4	0	0	?	1	0	0	0
?	?	?	0	0	0	1	1	?	0	0
1	2	?	1	?	0	1	?	1	?	?
?	0	0	1	?	0	?	0	0	0	0
?	?	?	1	0	0	0	0	0	-	-
-	0	0	-	-	-	-	0	1	1	1
0	0	0	0	0	0	0	0	2	0	0
0	0	0	0	0	0	-	0	0	0	0
1	0	1	?	?	?	0	0	0	2	0
0	0	0	0	0	0	?	1	1	1	1
0	0	0	?	1	?	?	1	0	0	0
0	0	0	0	0	0	0	-	-	?	0
1	0	0	?	?	?	1	0	1	0	1
0	1	2	2	?	?	2	0	2	?	1
?	?	?	0	1	0	1	2	?	0	1
0	?	2	1	0	0	?	1	?	0	1
?	0	0	?	?	0	0	1	1	?	0
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Pietraroiasuchus_ormezzanoi			1	?	?	1	?	0	0	0
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?	0	0	0	1	0	0	0	0	1	0
0	0	?	0	0	?	0	-	0	0	0
0	0	0	1	1	?	?	0	0	1	2
0	?	0	0	0	0	0	?	?	1	?
1	0	0	0	?	?	?	?	1	2	0
0	0	?	0	0	0	0	0	-	-	?
0	1	0	0	?	?	0	1	0	?	0
?	0	?	2	?	?	?	2	?	2	?
1	?	?	?	?	?	?	?	2	?	0
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0	?	?	?	?	0	0	0	0	0	1
1	1	1	0	0	0	3	0	-	-	2
2	?	?	?	?	?	2	?	?	?	?
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?	?	?	0	0	0	0	0	?	?	2
0	0	1	2	0	0	0	0	0	0	0
0	0	0	3	?	?	?	?	?	?	?
0	?	0	?	0	1	1	?	?	0	0
?	?	0	0	0	?	?	?	?	?	?
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0	?	?	?	?	?	0	2	?	?	?
?	2	?	?	?	?	?	?	?	1	2
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?	0	2	?	?	1	0	?	?	?	?
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?	0	0	3	1	?	0	?	?	?	?
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?	1	1	1	1	2	1	1	0	0	1
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Pachycheilosuchus_trinquei			?	?	?	?	?	?	?	?
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?	?	1	0	0	0	3	0	-	-	2
2	0	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	2
0	0	1	2	0	0	0	0	?	0	0
0	0	0	3	?	?	?	?	?	?	?
0	?	0	?	?	?	?	0	0	?	0
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?	?	?	?	0	0	0	2	?	?	1
0	2	?	?	?	?	?	0	?	1	2
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	0	2	0
?	?	?	0	2	0	0	0	0	0	0
0	?	0	1	0	?	?	?	?	?	1
1	0	2	?	?	1	0	?	1	0	0
?	0	0	0	0	?	0	0	?	0	?
?	0	0	3	1	1	0	?	?	?	?
1	?	?	?	?	?	?	?	?	?	?
?	1	1	1	?	?	?	1	0	0	1
1	0	0	2	0	0	1	?	?	?	?
?	?	?	?	?	-	-	-	-	-	
Iharkutosuchus_makadii	1	?	?	1	2	0	0	0	0	
0	1	?	?	0	?	0	2	0	0	?
?	?	?	?	1	2	?	?	?	?	0
?	0	0	0	?	0	0	1	0	0	1
?	0	0	0	0	0	2	1	?	0	0
1	2	?	1	?	0	0	-	1	0	?
0	0	0	1	0	0	?	0	0	0	0
0	?	2	-	0	0	0	0	0	-	-

-	0	0	-	-	-	-	0	1	1	1
0	2	-	-	-	-	-	-	-	-	-
-	-	-	0	-	0	-	0	0	0	0
0	0	1	1	?	?	-	-	-	2	-
-	0	0	0	0	0	0	0	0	-	1
-	-	0	0	1	0	2	0	1	0	0
0	?	1	0	0	0	0	-	-	?	0
1	0	0	?	3	0	1	?	1	0	1
0	1	2	0	1	1	1	1	2	?	1
0	0	2	0	0	0	0	2	0	0	1
0	?	3	1	1	0	0	1	1	0	1
?	0	0	0	0	?	0	1	1	?	0
?	?	?	?	0	2	0	?	1	1	?
0	?	?	?	?	?	?	1	1	0	0
2	1	3	?	0	0	0	1	0	2	1
1	0	0	0	0	3	0	-	-	2	0
0	?	?	?	?	2	?	?	?	0	?
?	1	?	?	?	?	0	1	?	?	?
?	?	0	1	1	1	?	?	?	?	?
?	?	0	0	0	0	0	0	0	2	0
1	1	2	1	0	0	0	0	0	0	0
0	0	2	?	0	{12}	0	?	?	?	0
0	0	1	0	1	1	0	0	0	0	?
?	0	0	2	0	?	0	0	0	0	0
0	-	0	0	0	?	?	0	0	0	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Gavialis_gangeticus	1	1	0	1	?	1	1	0	0	
1	1	?	?	0	?	0	2	0	0	0
0	0	1	1	1	2	1	0	0	0	0
-	0	1	0	0	0	0	1	0	0	1
?	0	0	?	0	0	0	1	?	0	0
1	2	?	1	?	2	1	1	1	?	?
0	0	0	1	0	0	0	0	0	0	0
0	?	0	2	0	0	1	0	0	-	-
-	0	0	-	-	-	-	0	1	1	1
1	0	0	0	4	0	0	0	1	0	0
0	0	0	0	0	0	-	0	0	0	0
0	1	0	0	?	?	1	0	0	0	0
0	0	0	0	0	0	0	0	1	1	1
0	0	0	0	?	0	?	1	0	2	1

0	1	0	0	0	0	0	-	-	1	0
1	0	0	?	3	0	1	0	1	0	1
0	1	1	2	1	0	2	0	2	?	1
0	0	?	0	0	0	1	2	0	1	1
0	?	3	1	1	0	0	1	1	0	1
?	0	0	0	0	0	0	1	1	0	1
?	0	1	0	0	2	0	0	1	1	0
1	?	?	0	0	1	1	1	1	0	0
2	2	3	0	0	0	0	0	0	1	1
0	0	1	0	3	3	2	0	0	2	0
?	1	0	0	0	1	?	?	0	0	0
0	0	0	1	0	0	0	1	1	0	0
0	0	0	1	3	1	?	?	?	?	?
?	?	0	0	0	0	0	0	0	1	?
?	0	?	?	?	0	?	?	?	?	0
0	0	?	?	0	1	0	1	0	0	0
0	0	1	0	1	1	0	0	0	0	?
?	0	0	0	0	1	1	0	0	0	0
0	-	0	0	0	0	4	0	0	0	0
0	?	0	0	0	0	2	0	?	?	?
2	0	0	?	?	0	0	?	1	2	0
0	-	0	0	0	0	-	?	0	0	?
?	?	0	?	0	0	0	?	?	?	?
0	0	0	1	0	0	0	0	0	0	0
?	0	1	0	0	1	0	0	1	?	?
0	2	?	?	1	0	?	1	0	0	?
0	0	0	0	?	?	0	1	0	1	?
0	0	2	1	1	0	?	1	1	?	1
1	1	1	?	0	?	0	0	0	2	2
1	1	1	0	1	1	1	0	0	1	1
0	0	?	0	1	?	?	0	0	0	1
1	1	?	1	0	0	?	0	2		
Crocodylus_porosus		1	1	0	1	2	0	0	0	0
0	1	?	?	0	?	0	2	0	0	0
0	0	1	1	1	2	1	0	0	0	0
1	0	1	0	0	0	0	1	0	0	1
?	0	0	?	0	0	2	1	?	0	0
2	2	?	1	?	0	1	1	1	?	?
0	0	0	1	0	2	0	0	0	0	0
0	0	0	1	0	0	0	0	0	-	-
-	0	0	-	-	-	-	0	1	1	1
1	0	0	0	0	0	0	0	2	0	0
0	0	0	0	?	0	-	0	0	0	0
0	1	1	0	?	?	1	0	0	0	0
0	0	0	0	0	0	0	0	1	1	1
0	0	0	0	?	0	?	1	0	0	0
0	0	1	0	0	0	0	-	-	1	0
1	0	0	?	3	0	1	0	1	0	1
0	1	2	2	1	0	2	0	2	?	1
0	0	?	0	0	0	1	2	0	1	1
0	?	3	1	1	0	0	1	1	0	1
?	0	0	0	0	0	0	1	1	0	1

0	0	1	0	0	2	0	0	1	1	0
0	?	?	0	0	1	1	1	1	0	0
2	2	3	0	0	0	0	0	0	1	1
1	0	0	0	0	3	2	0	0	2	0
?	1	0	0	0	2	?	?	0	0	0
0	0	1	1	0	0	0	1	1	0	0
0	0	0	1	1	1	?	?	?	?	?
?	?	0	1	0	0	0	0	0	2	?
?	0	?	?	?	0	?	?	?	?	0
0	0	?	?	0	1	0	0	0	?	1
0	0	1	0	1	1	0	0	0	0	?
?	0	0	0	0	1	1	0	0	?	2
0	-	0	0	0	?	?	0	0	0	0
0	0	0	0	0	0	2	0	?	?	?
2	0	0	?	?	0	0	?	1	2	0
0	-	0	0	0	0	-	?	1	0	?
?	?	0	?	0	0	0	0	?	?	?
0	0	0	1	0	0	0	0	0	0	0
?	0	1	0	0	1	0	0	1	1	1
0	2	?	?	1	0	?	1	2	1	?
0	0	1	0	?	?	0	1	0	1	?
0	0	1	1	1	0	?	1	1	?	1
1	1	1	?	0	?	0	0	0	2	2
1	1	1	0	2	0	1	0	0	1	1
0	0	?	0	1	?	?	1	0	0	1
1	1	?	1	0	0	1	1	1		
Crocodylus_niloticus	1	1	0	1	2	0	0	0	0	
0	1	?	?	0	?	0	2	0	0	0
0	0	1	1	1	2	1	0	0	0	0
1	0	1	0	0	0	0	1	0	0	1
?	0	0	?	0	0	2	1	?	0	0
2	2	?	1	?	0	1	1	1	?	?
0	0	0	1	0	2	0	0	0	0	0
0	0	0	1	0	0	0	0	0	-	-
-	0	0	-	-	-	-	0	1	1	1
1	0	0	0	0	0	0	0	2	0	0
0	0	0	0	?	0	-	0	0	0	0
0	1	1	0	?	?	1	0	0	0	0
0	0	0	0	0	0	0	0	1	1	1
0	0	0	0	?	0	0	1	0	0	0
0	0	1	0	0	0	0	-	-	1	0
1	0	0	?	3	0	1	0	1	0	1
0	1	2	2	1	0	2	0	2	?	1
0	0	?	0	0	0	1	2	0	1	1
0	?	3	1	1	0	0	1	1	0	1
?	0	0	0	0	0	0	1	1	0	1
?	0	1	0	0	2	0	0	1	1	0
0	1	?	0	0	1	1	1	1	0	0
2	2	3	0	0	0	0	0	0	1	1
1	0	0	0	0	3	2	0	0	2	0
?	1	0	0	0	2	?	?	0	0	0
0	0	1	1	0	0	0	1	1	0	0

0	0	0	1	1	1	?	?	?	?	?
?	?	0	1	0	0	0	0	0	2	?
?	0	?	?	?	0	0	1	0	?	0
0	0	?	?	0	1	0	0	0	0	1
0	0	1	0	1	1	0	0	0	0	?
?	0	0	0	0	1	1	0	0	0	0
0	-	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	2	0	?	?	?
2	0	0	?	?	0	0	?	1	2	0
0	-	0	0	0	0	-	?	1	0	?
?	?	0	?	0	0	0	0	?	?	?
0	0	0	1	0	0	0	0	0	0	0
?	0	1	0	0	1	0	0	1	1	1
0	2	?	?	1	0	?	1	2	1	?
0	0	1	0	?	?	0	1	0	1	?
0	0	1	1	1	0	?	1	1	?	1
1	1	1	?	0	?	0	0	0	2	2
1	1	1	0	2	0	1	0	0	1	1
0	0	?	0	1	?	?	1	0	0	1
1	1	?	1	0	0	1	1	1		
Alligator_mississippiensis			1	1	0	1	2	0	0	0
0	0	1	?	?	0	?	0	2	0	0
0	0	0	1	1	1	2	1	0	0	0
0	1	0	1	0	0	0	0	1	0	0
1	?	0	0	0	0	0	2	1	?	0
0	1	2	?	1	?	?	0	1	1	?
?	0	0	0	1	0	2	0	0	0	0
0	0	0	2	-	0	0	0	0	0	-
-	-	0	0	-	-	-	-	0	1	1
1	1	0	0	0	0	0	0	0	2	0
0	0	0	0	0	?	0	-	0	0	0
0	0	1	1	0	?	?	1	0	0	2
0	0	0	1	0	0	0	0	1	1	1
1	0	0	0	0	1	0	0	1	0	0
0	0	0	1	0	0	0	0	-	-	1
0	1	0	0	?	3	0	1	0	1	0
1	0	1	2	2	1	0	2	0	2	?
1	0	0	?	0	1	0	1	2	0	1
1	0	?	3	1	1	0	0	1	1	0
1	?	0	0	0	0	0	0	1	1	0
1	0	0	1	0	0	2	0	0	1	1
0	0	1	?	0	0	1	1	1	1	0
0	2	2	3	0	0	0	0	0	0	1
1	1	0	0	0	0	0	2	0	0	2
0	?	1	0	0	0	2	?	?	0	0
0	0	0	0	1	0	0	0	1	1	0
0	0	0	0	1	1	1	?	?	?	?
?	?	?	0	1	0	0	0	0	0	2
?	?	0	?	?	?	0	1	1	0	0
0	0	0	3	?	0	1	0	0	0	0
1	0	1	1	0	1	1	0	0	0	0
?	?	0	0	0	0	1	1	0	0	0

0	0	-	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	2	0	?	?
?	2	0	0	?	?	0	0	?	1	2
0	0	-	0	0	0	0	-	?	1	0
?	?	?	0	?	0	0	0	0	2	0
0	0	0	0	1	0	0	0	0	0	0
0	?	0	1	0	0	1	0	0	1	1
1	0	2	?	?	1	0	?	1	1	0
?	0	0	0	0	?	?	0	1	0	1
?	0	0	1	1	1	0	?	1	1	?
1	1	1	1	?	0	?	0	0	0	2
2	1	1	1	0	1	1	1	0	0	1
2	0	0	?	0	1	?	?	1	0	0
1	1	1	1	1	0	1	0	1	0	
Plagiophthalmosuchus_gracilirostris				1	0	0	0	0	2	1
0	0	0	3	1	1	0	0	0	2	?
?	?	?	?	0	?	0	?	0	1	1
0	0	-	0	1	1	?	0	0	1	0
1	0	1	0	0	?	-	0	0	1	0
0	0	1	2	0	1	0	2	1	-	0
0	0	0	1	?	1	?	0	0	0	0
0	0	0	?	0	1	0	0	?	1	0
1	1	0	1	1	0	0	1	1	0	0
0	0	?	0	1	0	0	0	0	0	1
0	-	0	0	-	0	0	0	-	0	0
0	?	0	0	0	0	1	0	0	0	1
0	0	0	0	0	0	1	1	0	1	0
-	1	2	0	0	0	1	0	2	2	1
0	0	0	0	1	0	0	0	0	-	-
0	0	0	0	0	0	3	0	1	0	0
0	0	1	?	?	?	1	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	?	1	1	1
0	1	0	0	0	0	?	?	0	1	1
0	0	?	0	?	?	?	?	?	?	?
?	?	0	?	?	{01}	?	?	1	0	?
0	0	?	1	?	?	?	?	?	0	0
0	1	1	0	2	0	?	?	2	1	0
2	0	0	?	?	?	0	?	?	0	?
0	?	?	?	?	?	?	?	{01}	1	?
0	?	?	?	0	2	4	?	0	?	?
?	?	0	?	0	0	0	0	?	?	?
0	0	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	1	?
0	?	?	?	?	0	1	1	0	0	0
0	0	1	0	0	0	0	1	?	?	0
?	?	?	?	?	0	0	0	4	0	0
0	0	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	0	0	?	0
0	?	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	1	?	?	?	?

?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	0	?	0	0	?	?	?	?	?	?
?	?	0	1	?	2	?	1	?	?	?
0	?	?	?	?	0	?	?	?	?	?
?	?	1	1	1	1	0	-	0	1	0
0	0	0	0	2	0	?	?	0	?	?
?	0	?	?	?	?	-	-	-	-	-
Mystriosaurus_laurillardi	1	?	?	?	1	0	1	0	0	
0	3	0	0	0	?	?	?	?	?	?
?	?	?	?	?	?	1	1	1	0	0
-	0	0	1	1	0	0	1	0	1	0
0	0	0	?	-	1	1	1	0	0	0
1	2	0	1	1	2	1	-	0	0	0
0	1	0	1	0	0	0	0	0	0	0
0	?	0	1	0	0	0	1	0	0	0
0	0	0	0	0	1	1	0	0	0	0
?	0	1	0	{01}	1	0	0	0	0	-
{01}	0	-	0	0	0	-	0	0	0	0
0	0	0	0	1	?	0	0	1	0	?
0	0	0	0	1	1	?	?	?	?	?
?	?	?	0	?	?	2	1	0	0	0
0	0	1	0	0	1	0	-	-	0	0
?	0	0	0	3	0	1	0	0	0	0
1	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	?	?	?	?	0	1
?	0	?	?	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	0	0	0	0	0	1
1	0	2	0	2	?	2	0	0	2	0
0	?	?	?	0	?	?	0	?	?	1
1	?	?	?	?	?	0	?	?	?	?
?	?	0	2	3	?	0	1	0	0	-
0	{01}	?	0	0	0	0	0	0	1	{01}
0	0	1	0	0	0	0	1	1	0	1
?	?	?	?	0	?	0	{01}	0	0	1
0	0	0	0	?	?	?	0	0	0	0
1	0	0	0	0	1	1	0	0	0	0
0	0	?	0	?	0	4	0	0	0	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?

?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Chinese_teleosauroid		1	3	1	0	1	0	1	0	0
0	0	0	0	0	0	0	2	0	0	1
1	?	?	2	?	2	0	1	1	0	0
-	0	0	1	1	0	0	1	0	1	0
0	0	0	0	-	1	0	1	0	0	0
1	2	0	1	0	2	1	-	0	0	0
0	1	0	1	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1	0	0	0
0	0	0	0	0	1	1	0	0	0	0
?	0	1	0	0	1	0	0	0	0	-
0	0	-	0	0	0	-	0	0	0	0
0	0	0	0	1	0	0	0	1	1	0
0	0	0	0	1	1	0	1	0	-	1
2	0	0	0	1	0	2	1	1	0	0
0	0	1	0	0	1	?	-	-	0	0
?	0	0	0	3	0	1	0	0	0	0
1	?	0	?	1	0	2	1	2	1	1
1	0	?	0	?	0	0	2	0	0	1
0	0	1	1	0	1	1	1	1	0	1
0	0	0	0	0	0	0	1	1	0	0
?	0	0	0	1	0	0	0	0	1	0
1	0	0	0	0	?	?	0	?	0	0
?	1	1	1	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	0	2	3	1	0	1	1	{12}	-
{01}	0	0	0	1	0	0	0	0	?	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	?	?	?	?	?	?
?	?	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	4	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Indosinosuchus_potamosiamensis		1	4	0	0	1	2	1		
0	0	1	0	1	1	0	0	0	2	0
0	?	?	?	?	2	0	2	0	1	1
0	0	-	0	0	1	1	0	0	1	0

1	0	1	0	0	0	-	1	0	1	0
0	0	1	2	0	1	0	2	1	-	0
0	1	0	1	0	1	0	0	0	0	0
0	0	0	0	0	1	0	0	0	1	0
0	0	0	0	0	0	0	1	1	0	0
0	0	?	0	1	0	1	1	0	0	0
0	-	0	0	-	0	0	0	-	0	0
0	0	0	0	0	0	1	0	0	0	1
2	0	0	0	0	0	1	1	0	0	0
-	1	2	0	0	0	1	0	2	1	0
1	0	0	0	1	0	0	1	0	-	-
0	0	0	0	0	0	3	0	1	0	0
0	0	1	?	0	?	1	0	2	1	2
1	1	1	0	1	0	0	?	0	2	?
?	1	0	?	1	1	0	1	1	1	1
0	1	0	0	0	0	0	0	0	1	1
0	0	?	0	0	0	1	0	0	0	0
?	0	1	0	0	0	0	1	?	0	?
0	0	0	1	1	?	0	0	0	0	0
1	1	1	0	2	0	2	?	2	0	0
2	0	0	1	1	0	0	1	?	0	1
0	1	1	1	0	0	?	?	0	1	1
0	0	0	0	0	2	3	1	0	1	0
0	-	0	1	0	0	1	0	0	0	0
1	0	?	0	1	0	0	0	0	1	1
0	1	0	0	0	?	?	?	?	?	0
?	?	0	?	0	0	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	4	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	-	-	-	-	-
Indosinosuchus_sp		1	4	0	0	?	2	1	0	0
0	0	?	?	0	0	0	2	?	?	?
?	?	?	?	?	?	0	1	1	0	0
-	0	0	1	0	0	0	1	0	1	0
1	0	0	?	-	1	1	1	?	0	0
1	2	0	1	0	2	1	-	0	0	?
?	?	?	1	0	0	?	0	?	0	?
?	?	?	?	0	0	?	1	?	?	0
?	0	?	?	?	?	?	0	0	0	0
?	0	?	?	?	1	0	0	0	0	-

0	0	-	0	?	0	-	0	0	0	0
0	0	0	0	?	0	0	0	1	1	0
0	0	0	?	?	1	?	0	?	?	1
2	0	0	0	?	?	2	1	0	0	0
?	?	?	?	?	?	?	-	-	?	?
?	?	?	?	3	?	1	0	0	0	0
1	?	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	1	1	1	0	1
0	?	0	?	?	?	0	1	1	0	0
?	?	?	?	?	?	?	?	?	?	?
1	?	?	0	?	1	?	0	?	0	0
?	1	1	?	0	?	0	?	?	1	1
1	0	?	?	?	?	2	1	0	2	0
0	?	?	?	?	?	?	0	?	0	?
?	?	0	?	?	?	0	1	1	0	0
0	0	?	?	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	0	?	?	?	?	?	?	?	?	?
?	?	?	?	0	?	0	1	?	0	?
?	?	0	0	1	1	0	0	0	0	0
1	0	?	0	?	1	{01}	0	?	?	0
?	?	0	0	0	0	4	0	0	0	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Platysuchus_multiscrobiculatus			1	5	0	0	1	2	1	0
0	0	3	0	0	0	0	0	2	0	0
?	?	?	?	2	?	?	0	1	1	0
0	-	0	0	1	?	0	0	1	0	1
0	1	0	0	?	-	1	1	1	?	0
0	1	2	0	1	0	2	1	-	0	0
0	0	1	0	1	0	0	0	0	0	0
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	0	0	1	1	0	0	0
?	?	0	1	0	0	1	0	0	0	0
-	0	0	-	0	0	0	-	0	0	0
0	0	0	0	0	1	0	0	0	1	0
1	1	0	0	0	1	1	?	0	0	-
1	2	0	0	0	?	?	2	1	1	0
0	0	0	1	0	0	1	1	-	-	0
0	?	0	0	0	3	0	1	0	?	0

0	1	?	0	?	1	0	?	?	?	1
?	1	?	?	?	?	?	0	?	?	?
?	?	?	?	?	?	?	1	?	1	0
?	0	0	?	?	?	?	?	1	1	?
?	?	?	?	?	?	?	?	?	?	?
?	1	?	?	?	?	?	?	?	?	0
0	?	?	1	?	0	0	0	?	0	1
1	1	0	2	0	?	3	2	1	0	2
0	0	1	1	0	0	?	?	0	?	0
1	?	?	?	?	0	?	0	1	1	0
0	0	0	0	1	4	?	0	0	0	0
0	0	1	0	0	0	0	0	0	0	0
0	0	0	1	?	?	0	0	1	0	0
1	0	0	?	?	0	?	0	1	0	0
1	0	0	0	0	1	1	0	0	0	0
0	?	0	0	0	0	1	1	0	0	?
?	0	-	?	0	0	0	4	0	0	0
0	0	?	?	0	0	1	0	0	0	?
?	0	?	0	?	?	0	0	?	0	0
?	0	-	0	0	0	0	-	?	?	?
0	0	{01}	?	?	0	0	0	1	2	?
1	?	0	0	2	1	0	0	0	0	0
0	0	0	0	0	0	1	0	0	1	?
0	0	2	{01}	0	1	0	0	0	0	0
0	0	0	0	0	?	?	?	?	?	0
0	0	1	2	2	1	1	0	1	1	0
0	0	?	1	0	0	0	0	0	0	2
2	1	0	1	1	0	-	0	1	1	0
0	0	0	2	0	0	1	0	?	0	0
0	?	?	1	1	-	-	-	-	-	
Teleosaurus_cadomensis			1	5	0	0	?	2	1	0
0	1	3	0	0	0	0	0	2	0	0
?	?	?	0	2	0	?	?	?	?	0
0	-	?	0	1	?	0	0	1	?	?
?	?	0	?	?	?	?	?	1	?	0
0	1	?	?	1	?	2	1	-	0	0
0	0	?	0	1	0	0	0	0	0	0
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	0	0	1	1	0	0	0
0	?	0	1	0	1	1	0	0	0	0
-	0	0	-	0	0	0	-	0	0	0
0	0	0	0	0	{01}	0	0	0	1	0
0	1	0	0	0	{01}	1	0	0	0	-
1	2	0	0	0	?	0	2	1	0	1
0	0	0	1	0	0	1	0	-	-	0
0	0	0	0	0	3	0	1	0	0	0
0	1	?	0	0	?	?	2	1	2	?
1	?	?	?	0	0	0	0	2	0	0
1	0	0	1	1	0	1	1	1	1	0
1	0	0	0	0	0	0	0	1	1	0
0	?	0	0	0	1	0	0	0	0	1
0	1	0	0	0	0	1	1	0	2	0

0	?	1	1	1	0	0	0	?	0	1
?	?	0	2	0	?	3	2	?	0	?
0	?	?	?	?	?	1	0	?	?	?
?	?	?	0	?	0	1	0	1	?	0
0	0	0	0	1	4	1	0	?	?	?
?	0	?	?	?	0	?	0	?	?	0
?	0	0	?	0	?	?	?	?	?	?
?	?	?	?	?	0	?	0	1	?	0
?	?	?	?	0	1	1	0	0	0	0
0	?	?	0	0	0	1	?	?	?	?
?	?	?	?	?	?	0	4	0	0	0
0	0	?	?	0	?	?	0	?	?	?
?	0	?	0	?	?	?	0	?	?	?
?	?	?	?	?	?	?	?	?	0	?
?	?	?	?	?	0	0	?	?	?	?
1	?	?	?	2	1	?	?	?	?	0
0	?	0	?	?	0	?	?	?	?	?
?	?	2	?	?	1	0	0	0	0	0
0	0	0	0	0	0	0	0	1	?	0
0	?	1	?	?	?	1	0	1	?	?
?	?	?	?	?	?	?	?	?	?	?
?	1	0	1	1	0	-	0	1	1	0
0	0	0	2	0	0	1	0	?	0	0
0	?	?	?	?	-	-	-	-	-	
Mycterosuchus_nasutus	1	4	0	0	0	2	1	0	0	
1	3	0	0	0	0	0	2	0	0	?
?	?	?	2	?	?	0	1	1	0	0
-	?	0	1	?	0	0	1	0	1	0
1	0	0	0	-	1	0	1	0	0	0
1	2	1	1	0	2	1	-	0	0	0
0	1	0	1	0	0	0	0	0	0	0
0	?	?	?	0	0	0	1	0	0	0
0	0	0	0	0	1	1	0	0	0	0
?	0	1	0	0	1	0	0	0	0	-
0	0	-	0	0	0	-	0	0	0	0
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	1	1	0	0	0	-	1
2	0	0	0	?	?	2	1	0	1	0
0	0	1	0	0	1	0	-	-	0	0
?	0	?	0	3	0	1	0	?	?	0
1	?	0	?	?	0	2	1	2	1	?
1	0	0	?	?	0	?	2	?	?	1
0	?	?	1	?	?	1	1	1	0	1
0	0	0	0	0	0	?	1	1	0	0
?	0	?	?	?	?	0	?	0	1	0
0	0	0	0	0	?	?	0	?	0	0
?	1	?	?	0	0	0	0	0	1	1
1	0	2	0	3	{23}	2	1	0	?	0
0	?	?	?	?	1	0	{01}	?	0	?
?	?	0	?	?	?	0	1	2	0	0
0	0	0	2	4	1	0	0	0	2	1
0	1	1	1	0	0	0	0	0	0	0

0	0	2	0	0	0	0	1	0	0	1
0	0	0	?	?	1	?	?	?	0	1
0	0	0	0	1	1	0	0	0	0	0
1	0	0	0	?	1	1	0	0	0	?
?	?	?	0	?	0	4	0	0	0	0
0	0	?	0	0	1	0	{01}	0	?	?
0	0	0	?	?	0	0	0	0	0	0
0	-	0	0	0	0	-	?	?	?	0
1	0	1	1	?	?	?	1	2	0	1
2	0	0	2	1	0	0	0	0	0	0
1	0	0	1	0	?	?	?	?	?	?
0	2	0	1	1	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	0
0	1	3	3	1	1	1	1	1	1	0
0	1	1	0	0	1	?	?	?	?	?
1	1	1	?	?	-	0	1	0	0	0
0	0	2	0	?	1	?	?	?	?	0
?	?	?	?	-	-	-	-	-		
Bathysuchus_megarhinus			1	?	?	0	0	2	1	0
0	1	0	1	?	3	-	0	1	0	?
?	?	?	?	?	?	?	0	1	1	0
0	-	0	0	1	1	0	0	1	0	1
0	1	0	0	0	-	1	0	1	0	0
0	1	2	1	1	0	2	1	-	0	?
?	?	?	?	?	0	0	?	?	?	0
?	?	?	?	?	0	0	?	?	?	?
?	?	?	?	?	?	?	?	?	0	0
0	?	0	1	0	0	1	0	0	0	0
-	0	0	-	0	?	0	-	?	?	?
?	0	0	?	?	?	?	0	0	1	0
0	?	?	0	0	1	1	?	0	?	?
1	2	0	0	0	?	0	2	1	?	?
0	?	0	?	?	?	?	?	-	-	?
?	?	?	?	?	3	?	1	0	?	?
?	?	?	0	?	1	0	?	?	?	1
?	?	0	0	0	0	?	?	?	?	?
?	?	?	?	?	?	?	1	1	1	0
1	0	0	0	0	?	?	0	?	?	0
0	?	0	?	?	?	?	?	?	?	?
?	0	?	?	0	0	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	?
?	?	0	2	0	3	3	?	?	?	?
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	?	0	1	4	?	0	0	1	2
1	1	1	1	1	0	0	0	0	0	0
0	0	?	1	0	0	0	0	1	0	0
1	0	0	?	1	0	0	0	?	?	0
1	0	0	0	0	?	1	0	0	0	0
1	1	0	?	0	?	1	1	0	0	0
?	?	?	?	?	?	0	4	0	?	?
?	0	?	?	?	?	?	?	?	?	?

?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	1	1	?	?	?	?	?	?	?	?
?	?	?	?	?	0	?	?	?	?	?
?	?	?	?	?	-	-	-	-	-	
Sericodon_jugleri		?	?	?	?	?	2	?	0	0
1	0	1	1	{13}	1	1	{01}	0	?	?
?	?	?	2	?	?	0	1	1	0	?
-	0	0	{01}	?	0	?	1	0	?	0
?	0	0	0	-	1	0	1	0	?	0
1	2	?	1	0	2	1	-	0	?	?
?	?	0	1	0	0	?	?	?	0	?
?	?	0	?	0	0	0	?	?	?	?
?	?	?	?	?	?	?	?	0	0	?
?	0	?	?	0	?	?	?	0	0	-
?	?	?	0	?	0	-	?	?	?	?
0	0	0	0	{01}	?	0	?	?	?	?
?	?	?	?	?	?	?	0	?	?	1
2	0	0	0	?	?	2	1	?	?	?
?	?	?	?	?	?	?	-	-	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	2	1	?
0	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	1	1	1	0	1
0	0	?	?	0	0	0	1	?	0	?
?	?	?	?	?	?	?	?	?	?	0
0	0	?	0	?	?	?	?	?	0	?
?	1	1	?	0	0	0	0	0	1	1
1	0	2	0	3	3	2	1	?	?	0
0	?	?	?	?	1	0	0	?	?	?
?	?	?	?	0	1	0	1	?	?	?
?	0	?	1	4	?	0	0	0	2	1
1	1	1	1	0	0	0	?	?	0	0
0	0	?	0	?	?	?	1	?	0	1
0	0	0	1	0	0	0	1	?	0	1
0	?	0	0	?	?	0	0	0	0	1
0	0	0	0	?	{12}	1	0	0	0	?
?	?	?	?	?	0	4	0	?	?	?
0	?	?	?	?	1	0	?	?	?	?
0	?	0	0	0	0	?	0	?	?	?
?	?	?	?	?	?	?	?	?	?	?
{12}	1	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	2	1	0	?	0	0	0	0	0	0

	0	0	0	0	0	0	0	1	0	?	?
	0	1	?	?	1	1	0	0	1	?	?
	0	1	?	?	?	?	?	?	?	?	?
	1	1	?	?	?	-	?	?	?	?	?
	?	?	2	0	?	?	?	?	?	0	?
	?	?	?	?	-	-	-	-	-		
Aeolodon_priscus		?	?	?	?	0	2	1	0	0	
	1	0	1	1	1	1	?	?	?	?	?
	?	?	?	?	?	?	0	1	1	0	0
	-	0	0	1	1	0	0	?	0	?	0
	1	0	0	?	-	1	0	1	?	0	0
	1	2	?	1	0	2	1	-	0	0	0
	0	1	0	1	?	0	?	?	?	0	?
	?	?	?	?	0	0	?	?	?	?	?
	?	?	?	?	?	?	?	?	0	0	0
	?	0	?	0	0	1	0	0	0	0	-
	0	?	-	0	0	0	-	?	?	?	?
	0	0	0	0	1	0	?	0	1	0	?
	?	?	0	?	1	1	?	0	?	?	?
	2	0	0	?	?	?	2	1	1	1	0
	?	?	?	?	?	?	?	?	-	-	0	0
	?	?	?	?	3	0	1	0	?	0	0
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	?	?	?	?	?	?	1	1	?	0	?
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	?	0	?	?	?	?	?	?	?	?	?
	?	?	?	?	0	0	0	0	0	{01}	1
	1	0	2	0	3	3	?	?	?	?	0
	0	?	?	?	?	1	0	0	?	0	?
	?	?	?	?	0	?	0	1	0	0	{01}
	0	0	?	2	4	1	0	?	?	?	?
	?	?	1	1	?	?	?	?	?	1	?
	?	0	1	0	?	?	?	1	?	?	1
	0	0	0	0	0	?	?	1	?	0	?
	?	?	?	0	?	?	0	0	0	0	0
	1	0	?	0	0	1	?	0	?	?	?
	?	?	?	?	?	0	4	0	0	0	0
	0	?	?	?	0	?	0	?	1	1	?
	0	?	0	?	?	?	0	?	0	0	{01}
	0	-	?	0	0	0	-	?	?	?	?
	0	1	?	?	?	?	?	1	?	?	?
	?	?	?	2	2	?	0	0	0	0	0
	0	0	0	1	0	0	0	?	?	?	?
	?	?	?	?	?	?	0	0	?	?	?
	?	?	?	?	?	?	?	?	?	0	{01}
	0	1	4	4	1	1	0	?	?	0	?
	?	1	?	0	?	?	0	0	0	2	?
	1	1	1	1	0	-	0	1	0	0	0
	0	0	?	0	0	1	0	?	?	0	0
	?	0	1	?	-	-	-	-	-		

Macrospondylus_bollensis			1	0	0	0	{01}	2	1	0
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0	-	0	1	1	0	0	0	1	0	1
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0	1	2	0	1	0	2	1	-	0	0
0	0	1	0	1	0	0	0	0	0	0
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0	0	0	0	0	0	1	1	0	0	0
0	?	0	1	0	0	0	0	0	0	0
-	0	0	-	0	0	0	-	0	0	0
0	0	0	0	0	1	0	0	0	1	1
0	0	0	0	0	1	1	0	0	0	-
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0	1	?	0	0	1	0	2	1	?	1
?	1	0	?	0	0	0	0	2	?	0
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0	?	0	0	0	1	0	1	0	0	1
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0	0	1	1	1	0	0	0	0	0	1
1	1	0	2	0	3	3	2	1	0	2
0	0	1	1	0	0	1	0	0	1	0
1	1	1	0	?	0	1	0	1	1	0
0	0	0	0	2	4	1	0	1	0	0
-	0	0	0	0	0	0	0	0	0	1
0	0	0	1	0	0	0	0	1	0	0
1	0	0	0	0	0	1	0	1	0	0
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0	1	0	0	0	0	1	1	0	0	?
?	0	-	?	0	0	0	4	0	0	0
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0	0	0	0	?	?	0	0	0	0	0
?	0	-	0	0	0	0	-	0	0	?
0	0	1	1	1	0	0	0	1	2	?
1	0	0	0	2	2	0	0	0	0	0
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0	0	2	1	0	1	0	0	0	0	0
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0	0	0	2	0	0	1	0	?	0	0
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Clovesuurdameredeor_stephani			1	?	?	?	?	?	?	?
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Andrianavoay_baroni		?	?	?	?	?	?	1	0	0
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0	0	1	0	0	0	0	1	0	0	1
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0	0	0	0	?	?	?	?	?	?	?
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Charitomenosuchus_leedsi			1	3	1	0	0	2	1	0
0	0	3	0	{01}	0	1	0	2	0	0
?	?	?	?	2	?	?	0	1	1	0
0	-	0	1	1	0	0	0	1	0	1
0	1	0	0	0	-	0	1	1	0	0
0	1	2	0	1	2	2	1	-	0	0
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0	0	0	0	0	0	1	1	0	0	0
0	?	0	1	0	0	0	0	0	0	0
-	0	{01}	-	0	0	0	-	0	0	0
0	0	0	0	0	1	0	0	0	1	2
0	0	0	0	0	1	1	0	0	0	-
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0	0	0	1	0	0	0	0	-	-	0
0	0	0	0	1	3	0	1	0	0	0
0	1	?	0	0	1	0	2	1	2	1
1	1	0	1	0	0	0	0	2	0	0

1	0	1	1	1	0	1	1	1	1	0
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0	?	0	?	0	1	0	1	0	0	1
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0	0	1	1	?	0	0	0	0	0	1
1	1	0	2	0	3	{23}	2	1	0	2
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0	0	0	0	2	4	1	0	1	0	1
-	0	1	0	0	0	0	0	0	0	0
0	0	0	1	0	0	0	0	1	0	0
1	0	0	0	0	0	1	0	1	?	0
1	0	0	0	0	1	1	0	0	0	0
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?	?	?	?	0	0	0	4	0	0	0
0	0	0	1	0	0	1	0	0	1	1
0	0	0	0	0	1	0	0	0	0	0
0	0	-	0	0	0	0	-	0	0	?
0	1	1	1	1	0	0	?	1	2	0
1	0	0	0	2	2	0	0	0	0	0
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0	0	2	1	0	1	0	0	0	0	0
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0	0	1	4	3	1	1	0	1	1	1
0	0	1	1	0	0	0	?	0	0	?
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0	0	0	2	0	0	1	0	?	0	?
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Seldsienean_megistorhynchus			?	?	?	?	?	2	?	0
0	0	?	?	?	0	1	?	?	0	?
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0	?	?	?	?	?	2	1	-	0	0
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1	1	0	2	0	3	3	2	{01}	0	?

0	0	?	?	?	0	1	0	0	?	0
1	1	?	?	?	0	1	0	1	1	0
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Deslongchampsina_larteti			1	?	?	?	1	2	1	0
0	0	3	0	0	0	1	0	2	0	0
?	?	?	?	2	?	?	0	1	1	0
0	-	0	1	1	0	0	0	1	0	1
0	?	0	0	0	-	0	?	1	0	?
0	1	2	0	1	?	2	1	-	0	0
0	0	1	0	1	0	0	0	?	0	0
?	0	0	0	1	0	0	0	1	0	0
1	0	0	1	0	0	1	1	0	0	?
0	?	0	?	0	?	0	0	?	?	0
-	?	?	-	0	0	0	-	0	0	0
0	0	0	0	0	1	0	0	?	1	1
?	0	0	0	0	?	?	?	?	?	?
1	2	0	0	0	?	?	2	1	1	0
0	0	0	1	?	?	0	0	-	-	?
0	?	0	?	0	3	0	1	0	0	0
0	1	?	?	?	1	0	2	1	2	1
1	1	0	?	0	0	0	?	2	0	?
?	?	1	?	1	0	1	1	1	1	0
1	0	?	0	0	?	?	?	?	?	0
0	?	0	?	?	?	?	1	?	?	?
0	1	0	0	0	0	1	?	?	?	0
0	?	1	1	?	?	?	?	0	?	1
?	1	?	?	?	2	?	2	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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-	0	1	0	0	0	0	0	?	0	?
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Proexochokefalos_heberti				1	3	1	0	1	2	1	0
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?	?	?	?	2	?	2	0	1	1	0
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0	1	2	0	1	1	2	1	-	0	0
?	0	0	0	1	0	0	0	0	0	0
0	0	?	0	1	?	0	?	0	0	-
-	-	0	0	-	-	-	-	0	0	0
0	?	0	1	0	0	0	1	0	0	0
-	0	0	-	0	?	0	-	0	?	?
?	0	0	0	0	1	0	0	0	1	1
0	0	?	?	?	1	?	0	0	0	-
1	2	0	0	0	1	0	2	1	1	0
0	0	0	1	0	0	0	0	-	-	?
?	?	0	?	1	3	0	1	0	0	?
0	1	?	0	?	1	0	2	1	?	1
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0	?	0	?	?	?	0	1	0	?	1
0	?	?	0	0	0	?	?	0	?	0
0	?	1	1	1	0	0	0	0	0	1
1	1	0	2	0	2	?	2	1	0	2
0	0	?	?	?	0	1	1	1	1	0
1	1	?	0	?	0	1	0	1	1	0
0	0	0	0	2	4	1	0	1	0	1
-	0	1	0	0	0	0	0	0	?	0
0	0	0	?	0	0	0	0	1	0	0
1	0	0	?	1	0	1	?	0	0	0
?	0	0	0	0	1	1	0	0	0	0
0	{01}	0	0	0	0	{12}	1	0	0	?
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Proexochokefalos_cf__bouchardi				?	3	1	0	?	2	?
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0	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	2	1	-	0
0	?	?	0	0	1	?	?	?	?	?
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0	?	?	0	1	?	0	0	1	0	0
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?	?	0	0	?	?	?	?	0	0	1
0	?	?	?	0	?	?	?	?	0	?
?	1	2	0	0	?	?	?	?	1	1
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Steneosaurus_rostromajor			?	?	?	?	?	?	1	?
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0	1	?	?	1	1	2	1	-	?	?
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0	0	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
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Neosteneosaurus_edwardsi			1	3	1	0	1	0	1	0
0	0	3	0	?	0	1	0	2	0	0

?	?	?	?	2	?	?	0	1	1	0
0	-	0	1	1	0	0	0	1	0	1
0	1	0	0	0	-	0	1	1	0	0
0	1	2	0	1	1	2	1	-	0	0
0	0	1	0	1	0	0	0	0	0	0
0	0	?	0	1	0	0	0	0	0	-
-	-	0	0	-	-	-	-	0	0	0
0	?	0	1	0	0	0	1	0	0	0
-	0	0	-	0	0	0	-	0	0	0
0	0	0	0	0	1	0	0	0	1	0
0	0	0	0	0	1	1	0	1	0	-
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0	0	0	1	0	0	0	0	-	-	0
0	?	0	0	1	3	0	1	0	0	0
0	1	?	0	?	1	0	2	1	2	1
1	1	0	{12}	0	?	?	?	2	?	?
1	0	1	1	1	?	?	1	1	1	0
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0	?	0	?	0	1	0	1	0	0	1
0	1	0	0	0	0	1	?	0	?	0
0	?	1	?	?	0	0	0	0	0	1
1	1	0	2	0	1	3	2	1	0	2
0	0	?	?	?	0	1	1	1	?	0
?	?	1	0	?	0	1	0	1	1	0
0	0	0	0	2	3	1	1	1	0	0
-	0	1	0	0	0	0	0	0	0	1
0	0	0	1	0	0	0	0	1	0	0
1	0	0	0	1	?	1	?	0	0	0
1	0	0	0	0	1	1	0	0	0	0
0	1	0	0	0	0	1	1	0	0	?
?	0	-	?	0	0	0	4	0	0	0
0	0	0	1	0	0	1	0	0	0	1
0	0	0	0	0	0	0	0	0	0	0
0	0	-	0	0	0	0	-	0	0	?
0	2	0	1	1	0	?	?	1	2	0
1	0	0	0	2	2	0	0	0	0	0
0	0	0	0	1	0	?	0	?	?	1
0	0	2	1	0	1	0	0	0	0	0
0	0	1	0	0	0	0	0	1	0	0
0	0	1	4	3	1	1	0	1	1	1
0	0	1	1	0	0	0	?	?	?	?
?	1	1	1	1	0	-	0	1	0	0
0	0	0	2	0	?	1	1	?	0	?
0	?	?	?	?	-	-	-	-	-	
Yvridiosuchus_boutilieri	1	3	1	0	1	0	1	0	0	
0	3	0	?	0	1	0	2	0	0	?
?	?	?	2	?	?	1	1	1	0	0
-	0	1	1	0	0	0	1	0	1	0
1	0	0	?	-	0	1	1	0	?	0
1	2	0	1	?	2	1	-	0	0	0
0	1	0	1	0	0	0	0	0	0	0
0	0	?	?	0	?	?	1	0	0	0

0	0	0	0	0	1	1	0	0	0	0
?	0	1	0	5	0	1	0	0	0	-
0	0	-	0	0	0	-	0	0	0	0
0	0	0	0	1	0	0	0	1	1	0
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2	0	0	0	?	?	2	1	{01}	0	0
0	0	1	0	?	0	0	-	-	0	0
?	?	?	1	3	0	1	0	0	0	0
1	?	?	?	?	?	?	?	2	1	1
?	0	?	0	1	0	0	2	0	?	1
0	1	1	1	0	1	1	1	1	0	1
0	0	0	0	0	?	0	1	1	0	0
?	0	?	?	1	0	1	0	0	1	0
1	0	0	0	0	1	?	0	?	0	0
?	1	1	?	?	?	?	0	?	1	?
1	0	2	0	?	?	2	?	0	2	0
0	?	?	?	?	?	?	1	?	0	?
?	?	0	?	?	?	0	1	1	0	0
0	0	0	2	3	1	1	1	0	0	-
0	1	0	0	0	0	0	0	0	1	0
0	0	1	?	?	?	?	?	?	?	?
?	?	?	1	0	0	0	0	0	1	1
0	0	0	0	1	1	0	0	0	0	0
1	0	0	0	0	0	1	0	0	2	1
2	1	1	0	?	0	4	1	0	0	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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Lemmysuchus_obtusidens			1	3	1	0	1	0	1	0
0	0	3	0	0	0	1	0	2	0	0
?	?	?	?	2	?	?	1	1	1	0
0	-	0	1	1	0	0	0	1	0	1
0	1	0	0	0	-	0	1	1	0	?
0	1	2	0	1	1	2	1	-	0	0
0	1	{01}	0	1	?	0	0	0	0	0
0	0	?	0	1	0	0	?	0	0	-
-	-	0	0	-	-	-	-	?	0	0
?	?	0	1	?	5	0	1	0	0	?
-	0	0	-	0	?	0	-	0	?	?
?	0	0	0	0	1	0	0	0	1	{01}
0	0	?	?	?	1	1	0	1	?	?
1	2	0	0	0	?	0	2	1	0	0

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?	?	0	?	1	3	0	1	?	?	?
0	1	?	?	?	1	0	2	1	2	1
1	1	0	?	?	?	?	?	?	?	?
1	?	1	?	?	?	?	1	1	1	0
?	0	?	0	0	0	?	0	1	1	0
0	?	0	?	?	1	?	1	?	?	?
0	1	0	0	0	0	?	?	0	?	0
0	?	1	?	?	?	?	0	0	0	1
1	1	0	2	0	1	?	2	?	?	2
0	?	?	?	?	0	1	1	1	?	0
?	?	?	0	?	?	?	0	1	1	0
{01}	0	0	0	2	4	1	1	1	0	0
-	0	1	0	0	0	0	?	?	?	1
0	0	0	1	0	0	0	0	1	0	?
1	0	0	0	1	?	0	?	?	?	1
1	0	0	0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	1	0	0	2
1	2	1	1	0	0	0	4	1	0	0
0	0	?	?	?	1	1	0	0	?	2
?	0	0	0	0	?	0	1	0	0	0
?	0	-	?	?	?	?	-	?	?	?
1	0	0	1	1	?	?	?	?	?	?
1	0	0	?	?	?	?	?	0	?	?
0	0	0	0	1	0	?	?	?	?	?
?	0	2	1	0	1	0	1	0	0	0
1	0	1	0	{01}	?	?	0	1	1	0
1	0	1	?	3	1	1	0	1	1	0
0	0	1	1	1	0	0	?	?	?	?
?	1	3	1	1	0	-	0	1	0	0
0	0	0	2	0	0	1	1	?	?	?
0	?	?	?	?	-	-	-	-	-	
Machimosaurus_buffetauti			1	3	1	0	1	0	0	0
0	0	3	0	0	0	1	0	2	0	0
?	?	?	?	2	?	?	1	1	1	0
0	0	0	1	1	0	0	0	1	0	1
0	0	0	0	0	-	0	1	1	0	?
0	1	2	0	1	1	2	1	-	0	0
0	0	1	0	1	0	0	0	0	0	0
0	0	?	?	?	0	0	0	0	0	-
-	-	0	0	-	-	-	-	0	0	0
0	?	0	1	0	5	0	1	0	0	0
-	0	0	-	0	0	0	-	0	0	0
0	0	0	0	0	1	1	0	0	1	0
0	0	0	0	0	?	?	0	{01}	0	-
1	2	0	0	?	?	0	2	1	0	0
0	0	0	1	0	0	?	?	-	-	0
0	?	0	?	1	3	0	1	0	?	?
0	1	?	0	?	1	0	2	1	2	1
1	?	0	1	0	?	0	?	2	?	?
1	0	?	?	?	?	1	1	1	?	0
1	0	0	0	0	0	?	?	1	1	0

0	?	0	?	?	?	?	?	?	?	?
?	1	0	0	0	0	?	?	0	?	0
0	?	1	1	?	0	0	0	0	0	1
1	1	0	2	0	1	?	2	1	0	2
0	0	?	?	?	0	1	1	?	?	0
?	?	1	0	0	0	?	0	1	{01}	0
{01}	0	0	0	3	3	1	1	-	-	-
-	0	-	0	0	-	0	0	0	0	1
0	0	0	1	0	0	0	0	1	0	0
1	0	0	0	1	0	0	0	0	?	1
1	0	0	0	0	1	1	0	0	0	0
0	1	0	0	0	0	0	{01}	0	0	2
?	?	?	?	0	0	0	4	1	0	0
0	0	{01}	1	?	?	1	0	?	?	?
?	0	?	0	0	?	?	?	?	?	?
?	0	?	?	?	?	?	?	?	?	?
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0	0	0	2	0	?	?	?	?	?	?
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Machimosaurus_mosae	1	?	?	0	2	0	0	0	0	
0	2	?	?	0	?	0	2	0	0	?
?	?	?	?	?	?	1	1	1	?	0
0	0	1	1	?	0	0	1	0	1	0
0	0	0	0	-	0	?	1	0	?	0
?	2	?	1	1	2	1	-	0	0	0
0	?	?	1	0	?	0	0	0	0	0
0	?	?	?	0	0	?	0	0	-	-
-	0	0	-	-	-	-	0	0	0	0
?	0	1	0	5	0	1	0	0	0	-
0	0	-	0	0	0	-	?	?	?	?
0	0	0	0	?	?	0	0	1	0	0
0	?	0	0	?	?	?	1	?	?	1
2	0	0	?	?	?	?	1	0	0	0
0	0	1	0	0	0	0	-	-	0	0
?	?	?	?	?	0	1	0	?	?	?
1	?	0	?	1	0	2	1	2	1	1
?	?	2	?	?	?	?	?	?	?	?
?	?	?	1	?	?	?	?	?	?	?
0	0	?	?	?	?	?	1	1	0	?
?	0	?	?	?	?	?	?	?	?	?
1	0	?	?	?	?	?	0	?	0	0
?	?	?	?	0	0	0	0	0	1	1
1	0	2	0	1	?	2	?	0	?	0
?	?	?	?	?	1	1	?	?	?	?
?	1	?	?	?	?	0	1	?	0	0

0	?	0	3	2	1	1	-	-	-	-
0	-	?	?	-	0	0	?	?	2	0
0	0	?	0	0	0	0	?	0	0	1
0	0	0	1	0	0	0	?	?	1	?
?	?	?	0	1	1	0	0	0	0	0
1	0	0	0	0	0	1	0	0	?	?
?	?	?	?	?	0	4	1	0	0	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	?	1	0	0	0	?
0	?	?	?	?	?	?	?	?	?	?
?	?	1	1	?	?	?	?	?	?	?
1	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	1	0	?	0	0	0	0	0	1
0	1	0	?	?	?	?	?	?	0	1
0	1	?	3	1	1	0	?	?	?	?
?	?	?	1	?	?	?	?	?	?	?
1	3	1	?	?	?	0	1	0	0	0
0	0	2	?	?	1	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Machimosaurus_hugii		?	?	?	?	?	0	0	0	0
0	2	?	?	?	?	?	?	0	?	?
?	?	?	?	?	?	?	?	?	0	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
1	2	?	1	1	?	1	-	0	?	?
0	?	?	1	?	0	?	0	0	0	0
0	?	?	?	0	0	?	?	?	?	?
?	?	?	?	?	?	?	?	0	0	?
?	0	?	?	5	0	1	?	0	?	-
?	?	-	?	?	?	-	?	?	?	?
?	?	?	?	?	?	?	0	?	1	?
?	?	?	?	?	?	?	?	?	?	?
2	0	?	?	?	?	?	1	0	0	0
?	?	?	?	?	?	?	-	-	?	?
?	?	?	?	?	?	?	0	?	?	?
1	?	?	?	?	?	?	?	2	?	1
?	?	?	?	0	?	?	2	?	?	?
?	?	?	?	?	?	1	?	?	0	1
1	?	?	?	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	0
1	0	0	0	?	?	?	0	?	0	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	1	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	1	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
0	?	?	1	?	?	?	?	?	?	?
?	?	?	?	?	0	0	?	?	1	?
?	?	?	0	1	1	0	0	0	0	0
1	0	0	0	0	0	{01}	0	0	2	1

2 1 1 ? 0 ? 4 1 ? 0 0
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Machimosaurus_rex ? ? ? ? ? 0 0 0 0
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? 0 ? ? 5 0 1 0 0 ? -
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2 ? ? ? ? ? 4 1 ? ? 0
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?	?	?	?	?	?	?	?	?	?	?
1	3	1	?	?	?	0	?	?	?	?
?	?	2	0	0	?	?	?	?	?	?
?	?	?	?	-	-	-	-	-		
Pelagosaurus_typus		1	2	1	0	0	2	1	0	0
0	3	?	?	0	?	0	2	0	0	1
1	0	0	2	0	2	0	1	1	0	0
-	0	1	0	0	0	0	1	0	1	?
?	0	0	?	0	0	0	1	?	0	0
1	2	?	1	?	2	1	-	0	0	?
0	1	0	1	0	0	0	0	0	0	0
0	0	0	1	0	0	0	1	0	1	0
1	0	0	0	1	1	1	0	0	0	0
?	0	1	0	0	0	0	0	0	0	-
0	0	-	0	0	0	-	0	0	0	0
0	1	0	0	?	?	0	0	0	0	0
0	0	0	0	1	1	-	1	0	-	1
2	0	0	0	1	0	2	2	0	0	0
0	0	1	0	0	0	0	-	-	0	1
0	0	0	?	3	0	1	0	0	1	0
1	1	0	0	1	0	2	1	2	?	1
1	0	?	0	0	0	0	2	0	0	1
0	0	1	1	0	1	0	1	1	0	1
?	0	0	0	0	1	0	1	1	0	0
0	0	0	0	0	0	0	0	0	1	0
1	0	0	0	0	1	1	0	2	0	0
?	1	1	1	0	0	0	0	0	1	1
1	0	0	0	3	3	2	1	1	2	0
0	1	1	0	{01}	1	?	?	1	0	1
1	1	0	0	0	?	0	1	1	0	0
0	0	0	2	3	1	?	?	?	?	?
?	?	0	0	0	0	0	0	0	0	0
0	0	?	0	0	0	0	1	0	0	1
0	0	0	0	0	1	0	1	?	0	0
0	0	1	0	1	1	0	0	0	0	?
?	0	0	0	0	1	1	0	0	0	0
0	-	0	0	0	0	0	0	0	0	0
0	0	1	0	0	1	0	0	?	1	0
0	0	0	0	?	0	0	0	0	0	1
0	-	0	0	0	0	-	1	0	?	?
?	?	1	?	0	0	0	2	2	?	0
0	0	0	2	1	0	0	0	0	0	0
?	0	0	0	0	1	0	0	1	1	0
0	2	?	?	1	0	?	0	0	0	?
0	0	0	0	?	?	0	1	0	0	?
0	1	2	2	1	1	?	2	1	?	0
0	1	1	?	0	?	1	1	1	2	?
1	1	1	1	0	-	0	1	0	0	0

0 0 2 0 0 0 ? ? ? 0 1
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Peipehsuchus_teleorhinus ? ? ? ? ? ? 1 0
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0	?	0	0	?	0	0	1	1	0	0
0	1	2	?	1	?	2	1	-	0	0
?	0	1	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	?	1
0	1	0	0	0	1	1	1	0	0	0
0	?	0	?	0	0	0	0	0	0	0
-	0	0	-	0	0	0	-	0	1	0
0	0	0	0	0	?	?	0	0	0	0
0	0	0	0	0	1	1	-	1	?	?
1	2	0	0	0	?	0	2	2	0	0
0	1	1	1	0	0	0	0	-	-	0
?	?	?	1	?	3	0	1	1	0	1
0	1	?	0	0	1	0	2	1	2	?
1	1	0	2	0	0	0	0	2	0	0
?	?	?	1	1	?	?	0	?	?	0
1	?	0	0	0	0	1	?	1	1	0
0	?	0	?	?	0	0	?	?	0	1
0	1	0	?	0	?	1	?	0	?	0
0	0	?	1	?	0	0	0	0	0	1
1	1	0	0	0	2	2	2	1	0	2
0	0	1	1	0	0	1	?	?	1	0
1	1	?	0	0	0	?	0	1	1	0
0	0	0	0	3	2	1	?	?	?	?
?	?	?	0	0	-	0	0	0	0	2
0	0	0	0	0	0	0	0	?	0	0
1	0	0	0	?	0	?	?	?	?	0
?	?	0	1	0	?	?	0	0	0	?
?	?	?	?	0	0	1	1	0	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
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Metriorhynchoid_indet_T			1	3	1	0	0	2	1	0
0	0	3	?	?	0	?	0	2	0	0
?	?	?	0	2	0	2	0	1	1	0
0	-	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	0
?	0	1	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	1	0	1
0	1	0	0	0	1	1	1	0	0	0
0	?	0	1	1	0	0	0	0	0	0

-	0	0	-	1	0	1	-	0	1	0
0	0	0	0	0	?	?	0	0	0	0
0	0	0	0	0	1	1	-	1	0	-
1	2	0	0	0	1	0	2	2	0	0
0	0	1	1	0	0	0	0	-	-	0
?	0	0	1	?	3	0	1	1	0	1
0	1	1	0	0	?	?	?	1	2	?
1	1	0	?	0	0	0	0	2	0	0
?	0	0	1	1	0	1	0	1	1	0
1	?	0	?	?	?	?	?	1	?	?
?	0	0	0	?	?	?	?	?	?	?
?	?	?	?	?	?	1	1	0	?	?
?	?	1	?	?	0	0	0	?	?	?
1	1	?	?	?	?	?	2	1	?	2
?	?	?	?	?	?	?	?	?	1	0
1	1	?	0	?	?	?	?	1	1	0
0	0	0	0	?	3	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	1	0	0	?	?
?	0	?	?	?	?	0	0	1	?	?
?	?	?	?	?	?	?	?	?	0	?
?	?	?	2	?	?	?	?	?	?	?
1	1	0	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
0	0	2	?	?	1	1	?	0	0	0
?	0	0	0	?	?	?	0	1	0	0
?	?	?	?	?	?	?	?	?	?	?
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0	0	0	2	0	0	?	?	?	?	?
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Magyarosuchus_fitosi	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	1	?	?	?	?	?	?
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?	?	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	0	0	0	?
?	0	0	0	0	?	1	0	0	0	0
0	-	0	?	?	?	4	0	?	?	0
0	?	?	?	?	?	?	?	?	?	?
0	?	?	?	?	?	?	1	0	0	?
?	?	1	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	2	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
0	2	?	?	1	1	?	0	0	0	?
0	?	0	0	?	?	0	?	?	?	?
0	1	?	2	?	1	?	2	1	?	?
0	1	1	?	?	?	?	?	?	?	?
1	2	1	1	?	?	?	2	0	0	0
0	0	2	0	0	?	?	?	?	?	?
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Eoneustes_gaudryi		?	?	?	?	?	?	1	0	0
0	3	?	?	0	?	?	?	0	?	?
?	?	?	?	?	?	?	?	?	0	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
1	?	?	?	?	2	?	?	0	0	?
0	1	0	1	?	?	0	0	0	0	0
0	0	1	0	0	0	0	0	1	2	0
1	0	0	0	1	1	1	0	0	0	?
?	0	1	1	?	?	?	?	0	0	?
0	0	?	1	0	1	0	0	1	1	0
0	0	0	0	?	?	0	0	0	0	0
0	0	0	0	1	?	?	?	?	?	?
?	?	?	?	?	?	?	2	1	0	0
0	1	0	0	0	0	0	?	?	0	?
?	?	1	?	?	0	1	1	0	?	0
?	?	?	0	?	?	?	1	2	?	?
1	?	?	?	?	?	?	2	?	?	?
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?	?	0	?	?	1	?	?	?	?	?
?	?	?	?	?	?	0	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	0	?	?	0	?	?	?
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Chile_metriorhynchoid		?	?	?	?	?	?	?	?	?
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?	?	?	?	?	0	?	?	?	?	?
?	?	?	?	?	?	?	?	0	0	?
?	0	1	?	0	0	0	?	0	1	?
0	0	?	2	0	1	?	0	1	?	?
?	?	?	?	?	?	?	0	0	?	0
0	?	0	0	?	?	?	0	?	?	?
?	?	?	?	?	?	?	{23}	1	?	?
?	?	0	0	0	0	0	?	?	0	?
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?	?	?	?	?	?	?	?	?	0	?
?	?	?	?	?	?	?	?	?	?	?
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Zoneait_nargorum		?	?	?	?	?	?	1	0	?
?	?	?	?	0	?	0	?	?	?	?
?	?	0	?	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	0	0	?	?
?	?	?	?	1	0	?	?	?	?	?
?	?	?	?	?	?	?	0	0	0	0
?	0	1	1	0	0	0	0	0	1	-
0	?	-	2	?	?	?	?	?	?	?
?	?	?	?	?	?	0	0	0	?	0
0	1	0	0	?	?	?	0	?	?	?
?	?	?	?	?	?	2	3	?	0	0
?	1	0	0	0	0	0	?	?	0	?
?	?	?	?	3	?	?	?	?	?	?
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Solnhofen_Cricosaurus		?	?	?	?	?	?	?	0	0
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?	?	?	?	?	?	1	1	1	0	0
-	0	1	3	?	0	-	3	0	1	?
?	0	-	?	0	0	3	1	-	1	0
1	2	?	1	?	?	1	-	?	1	?
?	?	?	1	0	0	0	0	0	0	0
0	1	?	?	1	0	1	0	1	2	0
1	0	0	1	1	1	1	1	?	?	?
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?	0	?	2	?	?	?	?	?	?	?
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?	?	?	0	1	1	?	?	?	?	?
?	?	?	?	?	?	?	3	1	0	0
0	1	0	0	0	0	0	?	?	0	1
0	0	1	?	3	0	1	1	0	1	0
1	?	2	0	?	?	?	?	?	?	?
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1	0	0	0	1	3	0	-	-	2	0
0	1	1	?	?	?	?	?	1	0	1
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0	?	?	?	2	1	0	2	?	?	0
0	?	?	?	0	0	0	?	0	0	?
0	2	1	1	2	1	1	?	?	?	?
?	?	2	?	1	0	1	2	2	?	?
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0	0	4	5	1	1	?	?	?	?	0
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-	-	-	-	-	-	?	-	0	1	1
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Cricosaurus_bambergensis			?	?	?	?	?	?	?	0
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1	?	?	0	?	0	1	0	?	?	0
0	0	0	1	0	0	0	0	0	0	0
?	?	0	0	0	0	1	1	0	0	0
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0	0	?	?	1	2	1	0	2	?	?
0	0	?	?	?	?	?	0	?	0	0
1	0	2	1	1	2	1	0	?	?	?
?	?	?	2	?	1	0	0	2	2	?
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1	-	-	0	1	-	-	-	-	-	

Cricosaurus_elegans		?	?	?	?	?	2	?	0	0
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-	0	1	3	?	0	-	3	0	?	?
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1	2	?	1	?	2	1	-	0	1	?
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?	?	?	?	1	0	?	0	1	2	0
1	?	?	?	1	?	?	?	0	0	0
?	0	1	2	0	0	0	0	1	1	-
1	0	-	2	0	1	0	0	1	0	0
0	0	0	0	?	?	0	2	0	0	?
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?	?	1	0	?	?	2	3	?	0	0
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1	?	2	?	?	?	?	?	?	?	?
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Cricosaurus_suevicus		0	3	1	?	?	2	1	0	0
0	2	?	?	0	?	1	0	?	?	?
?	?	?	?	?	?	1	1	1	0	0
-	0	1	3	?	0	-	3	0	1	?
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1	2	?	1	?	2	1	-	0	1	?

0	1	0	1	0	0	?	0	0	0	0
0	1	1	0	1	0	1	0	1	2	0
1	?	?	?	1	?	?	1	0	0	0
?	0	1	2	0	0	0	0	1	1	-
1	0	-	2	0	1	0	0	1	0	0
0	0	0	0	?	?	0	2	0	0	1
1	1	?	0	1	1	?	0	?	?	1
2	0	1	0	?	?	2	3	1	0	0
0	1	0	0	0	0	0	1	0	0	1
0	0	1	?	3	0	1	1	0	1	0
1	?	2	0	?	?	2	?	?	?	?
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0	?	?	?	1	0	0	?	0	1	0
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1	?	0	?	1	1	?	1	?	0	1
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0	1	1	1	2	1	0	2	?	?	0
0	?	1	?	0	1	0	?	0	0	1
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Cricosaurus_schroederi	0	3	1	0	?	?	1	0	0	
0	0	?	?	3	?	1	0	0	?	?
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?	0	1	3	?	0	0	0	1	1	-
1	0	-	2	0	1	0	0	1	0	0
0	0	0	0	?	?	0	2	0	0	1

1	1	0	0	1	1	?	0	?	?	1
2	0	1	0	1	?	2	3	1	0	0
0	1	0	0	0	0	0	1	0	0	1
?	?	1	?	3	0	1	1	0	?	0
1	?	2	0	?	?	?	?	?	?	?
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Cricosaurus_araucanensis			0	3	1	0	0	2	1	0
0	0	0	?	?	3	?	1	0	0	0
?	1	1	0	2	0	2	1	1	1	0
0	-	0	1	3	0	0	-	3	0	1
?	?	0	-	0	0	0	3	1	-	1
0	1	2	?	1	?	2	1	-	0	1
?	0	1	{01}	1	0	0	0	0	0	0
0	0	1	1	0	1	0	1	0	1	2
0	1	0	0	1	1	1	1	1	0	0
0	?	0	1	2	4	0	0	0	1	1
-	1	0	-	2	0	1	0	0	1	0
0	0	0	0	0	?	?	0	2	1	0
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1	2	0	1	0	1	0	2	3	1	0
0	0	1	0	0	0	0	0	1	0	0
1	0	0	1	?	3	0	1	1	0	1
0	1	1	2	0	1	?	2	1	2	?
1	1	0	0	1	-	1	0	2	0	0

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1	?	0	0	0	0	1	0	1	1	0
0	1	0	0	1	0	0	0	0	0	1
0	1	0	0	0	0	1	1	0	2	0
0	0	1	1	1	1	0	0	0	0	1
0	1	0	0	0	2	3	0	-	-	2
0	0	1	1	1	0	1	?	?	1	0
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1	0	0	1	3	4	1	?	?	?	?
?	?	?	0	0	-	0	0	0	0	1
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?	?	0	0	0	0	1	1	0	0	0
0	0	-	0	0	0	0	0	0	0	0
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?	0	?	1	?	?	0	0	0	0	?
?	?	?	?	?	?	?	?	?	0	?
?	?	?	2	?	?	?	?	2	2	0
?	?	?	2	2	0	1	1	1	2	1
1	?	1	?	0	1	0	1	0	?	1
0	0	2	?	?	1	0	?	-	0	0
?	1	-	-	1	0	0	1	?	1	0
?	0	0	4	?	1	1	?	2	?	?
0	0	2	0	?	?	?	?	?	?	?
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1	-	-	0	1	-	-	-	-	-	
Cricosaurus_vignaudi	?	?	?	?	?	2	1	0	0	
0	0	?	?	3	?	1	0	?	?	?
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?	0	-	?	?	?	3	1	-	?	?
1	?	?	?	?	2	1	-	0	1	?
0	?	0	1	?	0	?	0	0	?	0
0	?	?	0	1	0	?	?	?	?	?
?	?	0	?	?	?	?	?	0	?	0
?	0	1	2	4	0	0	0	1	1	-
1	?	-	2	0	1	0	0	1	0	0
0	0	0	0	?	?	0	2	0	0	1
1	1	?	0	1	1	?	0	?	?	?
2	0	1	0	?	?	?	3	?	0	0
0	1	?	?	?	?	?	1	0	0	1
?	?	?	?	?	?	?	1	0	1	0
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Cricosaurus_lithographicus			?	?	?	?	?	2	1	0
0	0	0	?	?	3	?	1	0	0	?
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?	-	0	1	3	?	0	-	3	0	1
?	?	0	-	?	0	0	3	1	-	1
0	1	2	?	1	?	1	1	-	0	1
?	0	1	0	1	0	0	?	?	?	0
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?	0	0	1	2	0	0	0	0	?	1
-	1	0	-	2	0	1	0	0	1	0
0	0	0	?	0	?	?	0	2	1	?
1	?	1	0	0	1	1	?	0	?	?
1	2	0	1	0	?	?	2	3	?	0
0	?	1	0	?	?	0	?	1	0	0
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?	?	?	?	?	?	?	?	2	0	0
?	?	?	1	1	0	2	0	1	0	?
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?	?	?	?	1	0	0	0	0	0	?
0	1	0	?	?	0	?	?	?	2	?
0	?	?	?	?	1	?	0	?	0	1
0	1	0	0	0	1	?	0	-	-	2
0	0	1	?	0	0	1	?	?	1	?
1	1	1	0	?	?	?	?	1	1	0
1	0	?	1	3	3	1	?	?	?	?
?	?	?	0	0	-	0	0	?	?	{12}
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Dakosaurus_lissocephalus			?	?	?	0	?	?	?	?
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1	2	0	1	0	?	?	2	?	?	0
0	?	1	?	?	?	?	?	1	0	?
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Cricosaurus_sp_Cuba		1	?	?	0	?	?	?	?	?
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Rhacheosaurus_gracilis		1	3	1	0	?	2	1	0	0
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1	2	?	1	?	2	1	-	0	1	?
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0	?	1	0	1	0	1	0	1	2	0
1	0	0	1	1	1	1	1	0	0	0
?	0	0	2	0	0	0	0	1	1	-
0	0	-	2	0	1	0	0	1	0	0
0	0	0	0	?	?	0	?	0	0	1
1	1	0	0	1	1	0	0	?	?	?
2	0	0	0	?	0	2	3	1	0	0
0	1	0	0	0	0	0	1	0	0	1
0	?	1	?	?	?	1	1	0	1	0
1	?	2	0	?	?	?	?	?	?	?
?	0	?	?	?	?	0	2	?	0	?
?	?	1	?	0	2	0	?	?	1	1
?	0	0	0	0	1	?	?	?	?	0
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?	?	?	1	1	0	0	0	0	1	0
1	0	0	0	?	3	0	-	-	2	0
?	1	1	0	?	1	?	?	1	?	1
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0	1	1	1	2	1	0	2	?	?	0
0	?	1	?	?	0	0	?	0	0	1
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0	0	?	2	?	1	1	1	2	1	1
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0	?	?	?	1	?	2	2	1	2	2
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Metriorhynchidae_indet_Cuba		1	?	?	?	?	?	?	1	0
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0	?	0	1	2	0	?	?	?	1	1
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0	?	0	?	?	?	?	?	1	0	0
?	1	?	0	0	1	?	?	0	?	?
?	?	?	0	?	?	?	?	3	1	0
0	0	1	0	0	0	0	0	1	0	0
?	?	?	?	?	?	?	1	1	0	?
0	?	?	2	0	?	?	?	?	?	?
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?	?	?	1	?	?	?	?	?	?	0
1	?	0	?	0	0	1	?	?	?	?
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0	1	0	?	?	?	1	?	?	?	?
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?	?	1	1	0	?	?	?	?	1	?
1	1	?	?	?	1	?	?	?	?	?
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0	?	0	1	2	?	?	?	?	?	?
-	0	0	-	2	?	1	0	0	1	0
1	?	0	0	0	?	?	0	2	0	0
?	1	1	0	0	?	?	?	?	?	?
?	?	?	?	?	?	?	?	3	1	0
0	0	1	0	0	0	0	0	0	1	0
?	?	?	1	?	?	?	?	1	0	?
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?	?	?	1	?	?	?	?	?	?	?
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?	1	0	?	?	?	?	?	?	?	?
?	?	?	?	?	1	0	0	?	0	1
0	1	0	0	0	?	?	0	-	-	2
0	?	1	1	0	?	?	?	?	1	?
1	?	1	?	0	?	?	?	1	?	0
?	?	?	1	3	2	?	?	?	?	?
?	?	?	0	0	-	0	0	?	?	1
0	?	0	?	?	?	?	?	?	?	?
?	?	?	?	?	1	1	0	1	?	0
?	?	?	?	?	1	?	0	0	0	0
?	?	0	0	0	0	1	1	0	0	0
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0	0	1	1	?	2	1	0	?	?	?
?	0	?	?	?	?	?	?	?	0	0
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Cricosaurus_saltillensis	?	?	?	?	?	0	?	0	0	
0	2	?	?	3	?	1	?	?	?	?
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-	0	1	3	?	0	-	3	0	?	?
?	0	-	?	0	0	?	1	-	1	0
?	2	?	1	?	2	1	-	0	1	?
0	1	0	1	0	0	?	0	0	0	0
0	?	?	?	?	?	?	0	1	2	0
1	0	0	?	?	?	?	?	0	?	0
?	0	1	3	0	0	0	0	?	1	-
0	?	-	2	?	1	0	0	1	0	0
0	0	0	0	?	?	0	2	0	0	?
1	?	?	0	?	1	?	?	?	?	1
2	0	0	?	?	?	?	3	?	0	0

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Metriorhynchus_palpebrosus			1	3	1	0	?	2	1	0
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0	-	0	1	3	?	0	-	3	0	?
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?	0	1	0	1	0	?	0	0	0	0
0	0	?	1	0	1	0	1	0	1	2
0	1	0	0	1	1	1	1	?	0	0
0	?	0	1	2	0	0	0	0	0	1
-	0	0	-	2	1	1	0	0	1	0
0	0	0	0	0	?	?	0	1	0	0
1	1	?	0	0	1	1	?	1	?	?
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0	?	?	?	0	?	?	2	1	2	?
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Maledictosuchus_nuyivijanan			?	?	?	?	?	?	?	0
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0	0	1	1	0	1	0	1	0	1	2
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?	?	?	?	2	?	1	?	?	1	0
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?	?	0	0	0	0	1	1	0	0	0
0	0	-	0	0	0	0	4	0	0	0
0	0	?	?	?	?	?	?	?	?	?
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Maledictosuchus_riclaensis			1	3	1	?	?	2	1	0
0	0	2	?	?	2	?	?	1	0	?
?	?	?	?	?	?	?	1	1	1	0
0	-	0	1	3	?	0	-	2	0	?
?	?	0	-	0	0	0	1	1	0	1
0	1	2	?	1	?	2	1	-	0	1
?	0	1	0	1	0	0	0	0	0	0
0	0	1	1	0	1	0	1	0	1	2
0	1	0	0	1	0	1	1	1	0	0
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-	0	0	-	2	0	1	0	0	1	0
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1	2	0	0	0	1	?	2	3	1	0
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?	0	0	1	?	3	0	1	1	?	1
0	1	?	2	?	1	0	2	1	2	?
1	1	0	1	0	0	1	0	2	?	0
0	0	0	1	?	0	3	?	1	1	1
1	?	0	?	0	0	1	?	?	?	?
0	?	0	?	1	?	0	0	0	0	?
0	1	0	?	0	?	?	?	0	?	?
?	?	1	1	1	?	?	?	?	?	?
?	?	0	0	0	?	?	?	?	?	?
0	0	?	?	?	?	1	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	?	1	3	4	1	?	?	?	?
?	?	?	0	0	-	0	0	?	?	1
0	0	0	2	?	0	0	0	?	0	0
?	0	0	?	?	0	{01}	0	1	?	0
0	0	0	1	0	1	1	0	0	0	?
?	?	0	0	0	0	1	0	-	0	0

0	0	-	0	0	?	0	4	?	?	?
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Gracilineustes_acutus		?	?	?	?	?	2	1	0	0
0	?	?	?	3	?	?	?	?	?	?
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-	?	1	3	?	?	0	2	?	?	?
?	0	0	?	0	?	0	1	?	?	?
1	?	?	?	?	2	1	-	0	?	?
0	?	0	?	?	?	?	?	?	?	?
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?	0	1	?	0	0	0	0	0	?	-
0	?	-	2	0	1	0	0	1	0	0
?	?	0	0	?	?	0	0	0	0	1
?	?	0	0	?	?	?	1	?	?	?
2	0	0	0	?	?	?	3	1	0	0
0	1	?	?	?	?	?	0	0	0	?
?	?	1	?	?	?	?	1	?	?	?
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Gracilineustes_leedsi		1	3	1	0	0	2	1	0	0
0	0	?	?	3	?	1	0	0	?	?
?	?	?	2	0	2	1	1	1	0	0
-	0	1	3	?	0	0	2	0	1	0
?	0	0	0	0	0	1	1	0	?	0
1	2	?	1	?	2	1	-	0	1	?
0	1	0	1	0	0	0	0	0	0	0
0	?	1	0	1	0	1	0	1	2	0
1	0	0	1	1	1	1	1	0	0	0
?	0	1	1	0	0	0	0	0	1	-
0	0	-	2	0	1	0	0	1	0	0
0	0	0	0	?	?	0	0	0	0	1
0	1	0	0	1	1	0	1	?	?	1
2	0	0	?	?	0	?	3	1	0	0
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0	0	1	?	3	0	1	1	0	1	0
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1	0	{01}	0	0	1	0	2	0	0	?
?	?	1	1	0	?	0	1	1	0	1
?	0	?	0	0	1	?	1	1	0	0
?	0	?	1	?	0	0	0	0	1	0
1	0	0	0	?	1	?	0	?	0	0
?	?	1	?	1	0	0	0	0	1	0
1	0	0	0	1	3	0	-	-	2	0
0	1	1	0	0	1	?	?	1	0	0
1	1	0	0	0	1	0	1	1	0	1
0	0	1	3	4	1	?	?	?	?	?
?	?	0	0	-	0	0	?	?	0	0
1	0	0	1	0	0	0	?	0	0	1
0	0	?	?	0	1	0	1	?	0	0
0	0	1	0	1	1	0	?	0	0	?
?	0	0	0	0	1	1	0	0	0	0
0	-	0	0	0	0	4	0	0	0	0
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0	1	1	?	?	0	0	?	0	0	0
0	1	1	1	2	1	0	1	?	?	?
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0	0	2	?	1	0	0	1	1	1	?
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?	2	?	?	1	0	?	-	0	0	?
?	?	?	?	0	0	1	?	?	0	?
0	0	?	4	1	1	?	2	1	?	0
0	2	0	?	1	?	2	1	1	2	2
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Metriorhynchus_geoffroyii ? ? ? ? ? ? 1 0
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Metriorhynchus_superciliosus 1 3 1 0 1 2 1 0
0 0 3 ? ? 0 ? 0 1 0 0
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0	?	0	0	0	0	0	1	1	0	1
0	1	2	?	1	?	2	1	-	0	1
?	0	1	0	1	0	0	0	0	0	0
0	0	?	1	0	1	0	1	0	1	2
0	1	0	0	1	1	1	1	1	0	0
0	?	0	1	1	0	0	0	0	0	1
-	0	0	-	2	0	1	0	0	1	0
0	0	0	0	0	?	?	0	0	0	0
1	0	1	0	0	1	1	0	0	0	-
1	2	0	0	0	1	0	2	3	1	0
0	0	1	0	0	0	0	0	0	0	0
1	0	0	1	?	3	0	1	1	0	1
0	1	?	1	0	1	0	2	1	2	?
1	1	0	1	0	0	1	0	2	0	0
0	0	?	1	1	0	1	0	1	1	0
1	?	0	0	0	0	1	0	1	1	0
0	1	0	?	1	0	0	0	?	0	1
0	1	0	0	0	0	1	1	0	?	0
0	0	1	1	1	1	0	0	0	0	1
0	1	0	0	0	1	2	0	-	-	2
0	0	1	1	0	0	1	?	?	1	0
0	1	1	0	0	0	1	0	1	1	0
1	0	0	1	3	3	1	?	?	?	?
?	?	?	0	0	-	0	0	0	1	1
0	0	0	0	0	0	0	0	1	0	0
1	0	0	0	?	0	1	0	1	0	0
0	0	0	1	0	1	1	0	0	0	0
?	?	0	0	0	0	1	1	0	0	0
0	0	-	0	0	0	0	4	0	0	0
0	0	1	1	0	2	1	0	2	2	?
0	0	1	1	1	1	0	0	1	0	0
0	0	0	1	1	2	1	0	1	0	?
?	?	?	2	?	1	1	0	2	2	0
2	0	0	1	?	1	0	0	1	1	1
1	?	0	0	0	1	?	1	?	?	1
0	0	2	?	?	1	0	?	-	0	0
?	1	-	-	1	0	0	1	1	1	0
?	0	0	4	4	1	1	?	2	1	?
0	0	2	0	?	?	?	2	1	1	2
?	-	-	0	0	-	-	-	-	-	-
0	-	-	-	-	-	-	?	-	0	1
1	-	-	0	?	-	-	-	-	-	
Metriorhynchus_casamiquelai			?	?	?	0	1	0	0	0
0	0	0	?	?	3	?	?	0	0	0
?	?	?	?	2	?	2	?	?	?	0
0	0	0	1	3	0	?	0	2	0	1
?	?	0	0	?	0	?	2	1	0	1
?	1	?	?	1	?	2	1	-	0	1
?	0	1	0	1	0	0	?	0	0	0
0	0	0	?	0	1	0	0	0	1	2
0	1	0	0	0	0	1	1	1	0	0
0	?	0	1	2	0	0	0	?	0	1

-	0	1	-	2	1	1	0	0	1	0
0	0	0	0	0	?	?	0	0	0	0
1	0	1	0	0	1	1	-	0	?	?
1	2	0	0	?	?	0	?	3	0	0
0	0	1	0	0	0	0	0	0	0	0
?	?	?	1	?	?	?	1	1	0	1
0	?	?	1	0	?	?	2	?	2	?
1	?	?	?	?	?	?	0	2	?	0
?	?	?	1	?	0	3	0	1	?	2
1	?	0	0	0	0	1	?	?	?	0
0	?	?	0	1	?	0	0	0	0	1
0	1	0	?	?	0	1	1	?	2	0
0	?	1	1	1	1	0	0	0	0	1
0	1	0	0	0	1	3	0	-	-	2
0	0	1	1	0	?	?	?	?	0	?
1	0	?	0	?	0	0	?	1	?	?
?	0	?	1	3	2	?	?	?	?	?
?	?	?	0	0	-	0	0	?	?	1
?	?	0	?	?	?	?	?	?	?	?
?	?	?	0	?	?	1	0	0	?	0
0	0	0	?	0	1	1	0	?	0	?
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-	?	-	?	0	?	?	?	?	?	?
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Metriorhynchus_westermanni			?	?	?	?	?	?	?	?
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?	?	0	1	2	?	?	?	?	?	1
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1	0	?	?	?	?	?	0	?	?	?
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?	1	?	0	?	?	?	?	?	?	?
?	1	0	?	?	?	?	1	?	2	?
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Neptunidraco_ammoniticus			?	?	?	?	?	?	0	?
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?	?	?	?	?	1	0	?	?	?	?
?	?	?	?	?	?	?	?	?	0	?
?	?	0	?	2	0	0	0	?	?	?
?	?	?	?	2	?	1	0	0	?	0
0	?	?	?	?	?	?	?	1	1	?
?	?	1	0	?	1	?	?	?	?	?
?	?	?	?	?	?	?	?	3	?	?
?	0	1	?	?	?	?	?	?	?	0
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?	?	?	?	?	0	1	0	0	?	0
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Metriorhynchus_brachyrhynchus				1	3	1	0	{12}	0	0
0	0	0	3	?	?	0	?	0	1	0
0	?	?	?	?	2	0	2	1	1	1
0	0	0	0	1	3	0	0	0	2	0
1	0	?	0	0	0	0	0	1	1	0
1	0	1	2	?	1	?	{01}	1	-	0
1	?	0	1	0	1	0	0	0	0	0
0	0	0	?	1	0	1	0	0	0	1
2	0	1	0	0	1	1	1	1	1	0
0	0	?	0	1	1	0	0	0	0	0
1	-	0	0	-	2	1	1	0	0	1
0	0	0	0	0	0	?	?	0	1	1
0	1	0	1	0	0	1	1	0	0	?
?	1	2	0	0	0	1	0	2	3	1
0	0	0	1	0	0	0	0	0	0	0
0	?	0	0	1	?	3	0	1	1	0
1	0	1	?	1	0	1	0	2	1	2
?	1	1	0	3	0	1	0	0	2	0
0	?	0	?	1	1	0	3	0	1	1
2	1	?	0	0	0	0	1	?	1	1
0	0	?	0	?	1	?	0	0	0	0
1	0	1	0	0	0	?	1	1	0	?
0	0	?	?	1	1	1	0	0	0	0
1	0	1	0	0	0	1	1	0	-	-
2	0	0	1	1	0	0	1	?	?	1
0	0	0	1	0	0	0	1	1	1	1
0	1	0	0	1	3	2	1	?	?	?
?	?	?	?	0	0	-	0	0	0	0

2	0	0	0	0	0	0	0	0	1	0
0	1	0	0	1	?	0	{12}	0	0	?
0	0	0	0	1	0	1	1	0	0	0
0	?	?	0	0	0	0	1	1	0	0
0	1	2	1	1	0	0	0	4	0	0
0	0	0	0	1	0	2	1	0	1	2
?	0	0	1	1	1	1	0	0	1	0
0	0	0	0	1	1	2	1	0	1	0
?	?	?	?	2	?	1	0	?	?	?
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1	0	0	2	?	?	1	0	?	-	0
0	?	1	-	-	1	0	0	1	1	1
0	?	0	0	?	3	1	1	?	2	1
?	0	0	2	0	?	?	?	?	?	?
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-	0	-	-	-	-	-	-	?	-	0
1	1	-	-	0	?	-	-	-	-	-
Tyrannoneustes_lythrodectikos			1	3	1	0	?	0	0	0
0	0	3	?	?	0	?	0	1	0	?
?	?	?	?	?	0	?	1	1	1	0
0	-	0	1	3	0	0	0	2	0	1
?	?	0	0	0	?	0	?	1	1	?
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0	?	0	1	1	0	0	0	0	0	1
-	0	?	-	2	0	1	1	0	1	0
0	0	0	0	0	?	?	0	1	1	0
1	?	1	0	0	1	1	0	0	?	?
1	2	0	0	0	?	0	2	3	1	0
0	?	1	?	?	?	?	?	0	0	0
?	?	0	?	?	3	0	1	1	0	?
0	?	?	?	?	1	0	2	1	2	?
1	1	0	{23}	0	1	0	0	2	0	?
?	?	?	?	?	?	?	0	1	1	2
1	?	0	?	0	0	1	?	?	?	0
0	?	0	?	?	?	?	?	?	?	?
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0	?	?	?	?	1	1	0	0	0	1
0	1	0	0	0	1	1	0	-	-	2
0	0	2	1	0	0	?	?	?	?	?
?	?	1	0	0	0	1	?	?	1	?
?	0	?	1	3	2	2	?	?	?	?
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1	0	0	1	?	1	?	?	?	?	?
0	0	0	1	0	1	1	0	0	0	0
?	?	0	0	0	0	1	1	0	0	0
1	2	1	1	0	0	0	2	0	0	0
0	0	?	?	?	?	1	0	1	?	?

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?	0	0	?	?	1	1	?	2	1	?
0	0	2	0	?	?	?	?	?	?	?
?	-	-	0	0	-	-	-	-	-	-
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1	-	-	0	?	-	-	-	-	-	
Swiss_hastifer	?	?	?	?	?	?	?	?	?	?
2	?	?	?	?	?	?	?	?	?	?
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0	1	3	?	0	0	2	0	1	0	?
0	0	0	0	0	1	1	1	1	0	1
2	?	1	?	{12}	1	-	?	?	?	?
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Chouquet_hastifer		?	?	?	?	?	0	0	0	0
0	2	?	?	2	?	?	?	0	?	?
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?	0	1	3	?	0	0	2	0	1	?
?	0	0	?	0	0	2	1	1	1	0
1	?	?	1	?	?	1	-	0	1	?
0	1	0	1	0	0	0	0	0	0	0
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?	0	1	2	0	0	0	0	?	1	-
0	?	-	2	?	1	1	0	1	0	0
0	0	0	0	?	?	0	1	1	0	?
?	1	0	0	1	1	?	?	?	?	?
2	0	0	?	?	?	?	3	?	0	0
0	1	?	?	?	?	?	0	0	0	?
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?	?	0	0	-	0	0	1	0	?	1
2	?	?	?	?	?	?	?	?	?	?
?	?	?	?	1	1	0	?	?	0	?
?	?	?	?	?	?	0	0	0	0	?
?	0	0	0	0	1	1	0	0	0	?
?	?	?	0	0	?	5	0	0	0	0
0	?	?	?	?	1	0	?	?	?	?
0	?	1	?	?	?	?	?	?	0	?
?	?	1	1	?	?	?	?	?	?	?
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Mr_Passmores_specimen			?	?	?	0	?	0	0	0
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0	1	2	?	?	?	1	1	-	0	?
?	0	1	?	1	0	0	0	0	0	0
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1	2	0	0	0	?	?	2	?	?	?
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0	?	?	?	?	?	1	0	?	?	?
?	?	?	0	0	0	?	0	-	-	2
0	0	2	?	?	?	?	?	?	?	0
?	?	1	0	0	?	?	?	1	?	0
?	?	?	1	?	2	2	?	?	?	?
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1	2	0	?	?	?	?	?	?	?	?
?	?	?	?	?	1	1	0	?	?	0
?	?	?	?	?	1	?	0	0	0	?
?	?	0	0	0	0	1	1	0	0	0
1	2	1	1	?	?	0	5	0	?	?
0	0	?	?	?	?	1	?	?	?	?
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cf_Torvoneustes_MANCH_J6459			?	?	?	?	?	?	0	
0	0	?	2	?	?	2	?	?	?	?
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1	?	0	1	0	1	?	0	?	0	0
0	0	0	?	?	?	?	?	?	0	1
2	0	1	0	0	1	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	1
0	0	0	0	0	0	?	?	?	?	?
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?	?	0	?	?	?	1	?	?	?	?
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1	0	1	0	0	1	1	0	1	?	?
1	2	0	0	0	1	0	2	3	1	0
0	0	1	0	0	0	0	0	0	0	0
?	?	0	1	?	3	0	1	1	0	1
0	1	?	1	0	?	?	?	?	?	?
?	1	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	0	1	0	2
1	?	0	0	1	1	1	?	?	?	0
0	1	0	0	1	?	?	?	?	?	?
?	?	?	?	?	0	?	?	0	?	?
?	?	1	1	1	1	1	0	?	?	?
?	?	?	?	?	?	?	0	-	-	2
?	?	2	1	?	?	?	?	?	?	0
?	?	1	0	?	?	?	1	1	1	0
1	0	0	1	?	2	2	?	?	?	?
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?	?	?	?	?	?	1	0	?	?	1
?	?	?	?	?	?	?	0	0	0	0
?	?	0	0	0	0	1	1	0	1	0
?	?	?	?	?	?	?	4	1	?	?
0	0	?	?	?	?	?	?	?	?	?
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Torvoneustes_carpenteri			?	?	?	?	?	0	0	0
0	0	2	?	?	3	?	1	0	0	?
?	?	?	?	?	?	?	?	?	?	0
0	?	0	?	3	?	0	0	2	?	1
0	?	0	0	?	0	?	1	1	1	?
?	1	?	?	1	?	1	1	?	0	1
?	0	1	0	1	0	0	0	0	0	0
0	0	?	?	0	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	?
0	?	0	1	2	0	0	0	0	0	?
-	0	?	-	2	?	1	1	0	1	0
0	0	0	0	0	?	?	0	1	1	0
1	0	1	?	0	1	1	?	?	?	?
?	?	?	0	?	?	?	?	3	1	0
0	0	1	?	?	?	?	?	0	0	0
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0	?	?	?	0	1	1	?	?	2	?
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1	0	?	1	3	1	2	?	?	?	?
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?	?	0	0	0	0	1	1	0	1	2
1	3	1	1	0	?	0	4	1	?	0
0	0	?	?	?	2	1	0	1	?	?
?	0	1	1	?	?	?	?	1	0	0
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?	0	0	?	?	1	1	?	2	1	?
0	0	2	0	?	?	?	?	?	?	?
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0	-	-	-	-	-	-	?	-	0	?
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Torvoneustes_mexicanus			?	?	?	?	?	?	?	?
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?	?	0	?	0	?	?	?	?	?	?
?	?	?	?	?	?	?	0	?	?	1
?	?	?	?	?	1	?	0	0	0	0
?	?	0	0	0	0	1	1	0	1	2
1	3	1	1	?	?	0	4	1	0	0
0	0	?	?	?	?	?	?	?	?	?
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Purranisaurus_potens		1	3	1	0	?	?	?	0	0
0	?	?	?	?	?	?	?	0	0	?
?	?	?	2	0	2	?	?	?	0	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	0	1	?
0	?	0	1	?	0	0	0	0	0	0
0	?	?	?	1	0	0	0	1	2	0
1	0	0	?	?	?	?	1	0	0	0
?	0	1	3	0	0	0	0	0	1	-
0	0	-	2	1	1	1	0	1	?	?
0	0	0	0	?	?	0	1	1	0	?
0	1	0	0	1	1	0	?	?	?	1
2	0	0	0	1	0	2	3	1	0	0
0	1	?	0	0	?	0	0	0	0	?
0	0	1	?	3	0	1	1	?	1	0
1	?	?	?	?	?	2	?	2	?	1
?	0	?	?	?	?	?	2	0	0	?
?	?	1	1	0	?	0	1	0	2	1
?	0	0	0	0	1	0	1	1	0	0
1	0	0	?	0	0	0	0	0	?	0
1	0	0	0	0	1	1	0	2	0	0
?	1	1	1	1	1	0	?	0	1	0
1	?	?	?	?	?	0	-	-	2	?
?	2	?	?	?	?	?	?	1	0	?
?	1	0	?	?	?	?	1	?	0	?
0	?	?	?	?	2	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	1	0	?	?	?	?
?	?	?	0	?	?	0	0	0	0	?
?	0	0	0	0	1	?	?	0	?	?
?	?	?	0	?	?	?	?	?	?	?
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leldraan_melkshamensis		?	?	?	?	?	?	?	?	?
0	?	1	?	?	0	?	?	?	?	?
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0	0	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	-	?	?
?	?	?	0	1	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	0	?	{12}	0	?	?	?	?	?
?	?	0	?	2	?	1	1	0	?	?
0	0	0	?	?	?	?	0	1	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
0	?	?	?	?	?	?	?	0	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	1	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	?
?	1	0	?	?	?	?	?	?	?	?
?	?	?	?	?	1	1	0	?	0	1
0	1	0	?	?	?	?	0	-	-	2
?	?	2	?	0	?	1	?	?	?	?
?	?	1	?	?	?	?	?	?	?	?
?	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	0	0	1	1	0	0
?	?	0	0	0	0	1	1	0	0	0
1	2	1	1	0	?	1	1	0	?	?
0	0	?	?	?	?	?	?	?	?	?
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Geosaurus_giganteus		?	?	?	?	?	0	?	?	0
?	1	?	?	3	?	?	?	?	0	?
?	?	?	?	?	?	1	1	1	0	0
0	0	?	3	?	0	0	2	?	?	?
?	?	0	?	?	?	2	1	0	?	?
2	?	?	?	?	1	1	-	0	1	?
0	1	0	1	0	0	0	0	0	0	0
0	?	1	0	1	0	0	0	1	2	0
1	0	0	1	1	1	1	1	0	?	?
?	0	1	2	0	0	0	0	0	?	-
0	0	-	2	?	1	1	0	1	0	0
?	0	0	0	?	?	0	1	1	0	?
0	?	0	0	1	?	?	0	?	?	?
?	?	?	?	?	?	?	3	1	0	0
0	1	0	0	0	0	0	0	0	0	1
?	0	1	?	3	0	1	1	?	?	0
1	?	1	0	?	?	2	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	0	?	?	?	?	?	?	?	0	0
?	?	?	?	?	?	?	?	0	?	?
?	?	?	?	?	?	?	?	?	0	?
?	?	?	?	1	1	0	?	0	1	0
1	0	0	0	1	1	0	-	-	2	0
0	2	1	0	0	1	?	?	1	?	0
0	1	?	?	?	?	?	?	?	?	1
?	?	1	3	1	1	?	?	?	?	?
?	?	?	?	-	?	0	0	0	3	?
?	0	0	?	0	?	?	?	?	?	?
?	?	2	?	1	2	0	0	1	0	1
0	?	1	0	0	0	1	1	0	0	?
?	0	0	0	0	1	1	0	0	0	2
3	1	1	0	0	1	0	0	0	0	0
0	?	?	?	?	?	0	?	?	?	?
0	?	1	?	?	?	?	?	?	?	?
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Geosaurus_grandis		?	3	1	0	?	0	0	0	0
0	1	?	?	3	?	?	1	?	?	?

?	?	?	?	?	?	1	1	1	0	0
0	0	1	3	?	0	0	2	0	?	0
?	?	0	?	0	0	2	1	0	?	0
1	2	?	1	?	1	1	-	0	1	?
0	1	0	1	0	0	?	?	?	0	?
?	?	?	?	?	0	?	?	?	?	?
?	?	?	?	?	?	?	?	0	?	0
?	0	1	2	0	0	0	0	0	?	-
0	0	-	2	?	1	1	0	1	0	0
0	0	0	0	?	?	0	1	1	0	?
?	1	0	0	1	?	?	0	?	?	1
2	0	0	0	?	?	2	3	?	0	0
?	1	?	?	?	?	?	0	0	0	?
?	?	?	?	?	?	1	1	?	?	0
1	?	?	?	?	?	2	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	1	?
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1	0	0	0	?	?	0	?	?	?	0
0	?	?	?	?	1	?	?	1	?	0
?	?	?	?	?	?	?	?	?	?	1
0	?	?	3	?	?	?	?	?	?	?
?	?	0	0	-	0	0	?	?	?	?
?	0	?	?	0	0	?	?	?	?	?
?	?	?	?	1	2	0	?	?	0	0
0	0	?	0	0	0	1	1	0	0	?
?	0	0	0	0	1	1	0	0	0	2
3	1	1	0	0	1	0	0	0	0	0
0	?	?	?	?	?	?	?	?	?	?
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Geosaurus_lapparenti		?	?	?	?	?	?	?	?	?
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?	?	1	2	?	?	?	?	?	?	?
?	?	?	2	1	1	1	0	1	?	?
?	0	?	?	?	?	?	1	1	?	?
?	?	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	3	?	?	?
?	?	?	?	?	?	?	0	0	0	?
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?	?	?	?	?	?	?	?	?	?	?
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?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	2	0	0	?	0	?
?	?	?	?	?	?	0	1	0	?	?
?	0	0	0	0	1	1	0	0	0	2
3	?	?	?	?	?	0	0	?	?	0
0	?	?	?	?	?	0	1	?	?	?
0	?	?	?	?	?	?	?	?	?	?
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Suchodus_durobrivensis			1	3	1	0	?	0	0	0
0	0	2	?	?	0	?	0	1	0	?
?	?	?	?	2	?	?	1	?	?	?
0	0	0	?	3	?	0	?	2	?	?
?	?	?	?	?	?	?	?	?	0	?
?	1	?	?	1	?	1	1	?	0	?
?	0	1	0	1	0	0	?	0	0	0
0	0	?	?	?	?	?	?	?	?	?
?	?	?	0	1	1	1	1	?	0	0
0	?	0	1	1	0	0	0	0	?	2
-	0	?	-	?	?	1	?	?	?	?
?	0	0	0	0	?	?	0	1	?	?
?	?	?	?	?	?	?	0	0	?	?
1	2	0	0	0	?	0	2	3	?	?

?	?	?	?	?	?	?	?	0	0	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	2	?
1	1	0	4	0	0	0	0	2	?	?
?	?	?	?	?	?	?	0	1	1	2
1	?	?	?	0	0	1	?	1	1	0
?	?	?	?	?	0	?	0	0	?	?
0	0	0	0	0	?	?	?	?	?	1
0	?	?	?	?	1	1	1	0	0	1
0	1	0	0	0	?	1	0	-	-	2
0	0	2	1	0	0	1	?	?	?	0
?	?	1	0	0	?	?	?	1	?	0
1	0	0	1	?	1	?	?	?	?	?
?	?	?	?	?	?	?	0	0	0	3
0	1	0	0	1	0	0	0	?	0	0
0	0	0	1	?	2	1	0	?	?	0
?	?	?	?	?	0	0	0	0	0	0
?	?	0	0	0	0	1	1	1	0	0
1	2	0	1	?	0	?	3	0	?	0
0	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
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Plesiosuchus_manselii		1	3	1	0	?	0	0	0	0
0	2	?	?	1	?	?	?	0	?	?
?	?	?	2	?	2	1	?	?	0	0
0	0	1	3	0	0	0	2	0	1	0
?	0	0	0	0	0	2	1	0	?	0
1	2	?	1	?	2	1	-	0	1	?
0	1	?	1	0	0	0	0	0	0	0
0	?	?	0	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	0	0	0
?	0	1	?	0	0	0	0	?	2	-
0	?	-	?	?	1	1	?	?	?	0
0	0	0	0	?	?	0	?	1	0	?
?	?	0	0	1	1	?	0	?	?	1
2	0	0	0	?	?	2	?	?	?	?
?	?	?	?	?	?	?	0	0	?	?
?	?	?	?	?	?	1	?	?	?	?
?	?	1	0	1	0	{12}	1	2	?	1
?	?	5	0	0	0	?	2	?	?	?
?	?	?	?	?	?	?	1	1	2	1
?	0	0	0	0	1	?	1	1	0	0

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1 0 ? 0 ? 1 1 0 ? 1 0
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Dakosaurus_andiniensis 0 3 1 0 ? 0 2 1
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0 1 1 1 0 1 0 0 0 1 2
0 1 0 0 1 1 1 1 1 0 0
0 ? 0 1 3 0 0 0 0 0 2
- 0 0 - 2 1 1 2 0 1 0
0 0 0 0 0 ? ? 0 2 1 0
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1 1 0 0 0 ? ? 2 3 1 0
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1 ? 0 ? 0 0 1 ? 1 1 0
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0 ? 1 1 1 1 1 0 0 0 1
0 1 0 0 0 1 0 0 - - 2
1 1 2 1 1 0 ? ? ? 1 0
0 ? 1 0 ? ? ? ? ? ? ?

1	0	0	1	3	0	1	?	?	?	?
?	?	?	0	0	-	0	0	?	?	3
?	1	0	?	?	?	?	?	?	?	?
?	?	?	?	?	2	1	0	0	1	0
0	0	?	1	0	0	0	0	0	0	0
?	?	0	0	0	?	1	1	2	0	0
2	3	1	2	0	0	0	0	0	0	0
0	0	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	-	-	-	?	?	?
?	?	?	?	?	?	?	?	-	?	?
?	-	-	?	?	-	-	-	-	-	
Dakosaurus_maximus		?	3	1	?	?	0	0	1	0
0	3	?	?	1	?	1	?	0	?	?
?	?	?	?	?	?	1	1	1	0	0
0	0	1	3	?	0	0	3	0	1	0
?	?	?	?	0	0	2	1	0	?	0
1	2	?	1	?	1	1	-	0	1	?
0	1	?	1	0	0	0	0	0	0	0
1	?	?	0	1	0	0	?	?	?	?
?	?	?	?	?	?	?	?	0	0	0
?	0	1	3	0	0	0	0	0	2	-
0	?	-	2	1	1	2	1	1	?	0
?	0	0	0	?	?	0	1	1	0	1
?	1	0	0	1	1	?	0	?	?	?
2	0	0	?	?	?	?	3	?	0	0
0	1	?	?	?	?	?	0	0	0	?
?	?	?	?	?	?	1	?	?	?	?
?	?	1	0	?	?	?	?	2	?	?
?	?	?	?	?	?	?	2	?	?	?
?	?	?	?	?	?	?	?	?	2	1
?	0	?	?	?	1	?	?	?	0	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	1	?	?	?	0	?
?	?	?	?	1	1	0	?	0	1	0
1	0	0	0	?	1	0	-	-	2	1
1	2	1	1	0	1	?	?	1	?	0
0	1	0	0	?	?	1	1	?	0	1
0	0	1	3	1	1	?	?	?	?	?
?	?	0	0	-	0	0	0	0	3	0
1	0	2	1	1	0	0	?	0	0	0
0	0	3	?	2	1	0	0	1	0	0
0	?	1	0	0	0	0	0	0	0	?
?	0	0	0	1	1	1	2	0	0	2

3	1	2	0	0	?	0	0	0	0	0
0	?	?	?	2	1	0	1	?	?	?
0	1	1	?	?	0	?	1	?	?	?
?	0	?	?	?	?	0	?	?	?	?
?	?	2	?	1	0	0	2	2	?	2
?	?	1	?	?	0	0	1	1	1	?
?	?	?	?	?	0	1	0	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	1	1	?	?
0	0	?	?	?	1	?	2	?	?	0
0	?	?	?	?	?	?	?	?	?	?
-	-	0	0	?	?	?	-	-	-	0
-	-	-	-	-	-	?	?	0	1	1
?	?	?	?	-	-	-	-	-		
Mr_Leeds_dakosaur	1	3	1	0	?	0	0	1	0	
0	3	?	?	0	?	0	1	0	?	?
?	?	?	2	0	?	1	1	1	0	0
0	0	1	3	?	0	0	?	?	?	0
?	0	0	?	0	0	2	1	0	?	0
?	2	?	1	?	1	1	-	0	1	?
0	1	0	1	0	0	?	0	0	0	0
1	?	1	?	1	0	?	0	1	2	0
1	1	0	1	1	1	1	?	0	0	0
?	0	1	1	0	0	0	0	0	2	-
0	0	-	2	1	1	1	1	1	0	0
0	0	0	0	?	?	0	1	1	0	1
0	1	0	0	1	1	?	0	?	?	1
2	0	0	0	?	?	2	3	1	0	0
?	1	?	0	0	?	0	0	0	0	?
0	0	?	?	?	0	1	?	?	?	0
?	?	?	?	?	?	?	?	2	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	1	1	2	1
?	0	?	0	0	1	?	1	1	0	?
?	0	?	?	?	?	?	?	?	?	0
1	0	0	0	?	?	?	0	?	0	0
?	?	?	?	1	1	0	0	0	1	0
1	0	0	0	?	?	0	-	-	2	0
?	2	1	0	0	?	?	?	1	0	?
?	1	?	?	?	?	?	1	1	0	1
0	0	1	3	1	1	?	?	?	?	?
?	?	0	0	-	0	0	0	0	3	0
1	0	?	?	?	?	?	?	?	?	?
?	?	?	?	2	1	0	0	?	0	0
0	0	1	0	0	0	0	0	0	0	?
?	0	0	0	1	1	1	1	0	0	1
2	1	1	0	0	0	3	0	0	0	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	0	1	0	0	?
0	?	?	?	?	?	?	?	?	?	?
?	?	2	?	?	?	?	?	?	?	?
?	?	?	2	0	0	0	1	1	?	1

?	0	?	?	1	0	1	0	?	?	?
?	?	?	?	?	?	?	?	?	0	?
1	-	-	1	0	0	1	?	?	?	?
?	?	4	?	?	1	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
-	-	0	?	-	-	-	-	-	-	0
-	-	-	-	-	-	?	-	0	?	?
-	-	0	?	-	-	-	-	-		
Vaches_Noire_dakosaur			?	?	?	?	?	?	?	1
0	0	3	?	?	0	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
0	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	0	1
?	0	1	0	1	?	0	?	0	0	0
0	1	?	1	0	1	0	0	?	?	?
?	?	?	?	?	?	?	?	1	?	?
?	?	?	1	?	?	0	?	?	?	?
?	?	?	?	2	?	1	1	1	1	0
0	0	0	0	0	?	?	?	1	?	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	3	?	0
0	0	?	?	0	0	?	0	?	?	?
?	0	1	1	?	?	0	1	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	0
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	?	?	?	?	?
?	?	?	?	?	?	1	?	?	?	?
?	?	?	?	?	?	?

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;

ctype ord: 7 26 38 47 62 71 112 181 183 193 224 242 250 282 301 359 385 388 397 409 450 453 467 468 470 482;

END;

APPENDIX S3.1

All continuous characters were standardized using (x-mean/standard deviation); 'x' indicates the original (in millimetres) measurement that was taken.

Time periods: TOAR (Toarcian); AAL (Aalenian); BAJ (Bajocian); BATH (Bathonian); CALL (Callovian); OXF (Oxfordian); KIMM (Kimmeridgian); TITH (Tithonian); BER (Berriasian); VAL (Valanginian); HAUT (Hauterivian). (0) indicates taxa not found, (1) indicates taxa found.

Group: T=Teleosauridae; M= Machimosauridae; Ma = Machimosaurini; OUT = outgroup (*Plagiophthalmosuchus gracilirostris*)

Taxon	Specimen	C1	C2	C3	C4
	C5	C6	D1	D2	D3
	D4	D5	D6	D7	D8
	D9	D10	D11	D12	
	D13	TOAR	AAL	BAJ	
	BATH	CALL	OXF	KIMM	
	TITH	BER	VAL	HAUT	
	Group				
Mycterosuchus nasutus NHMUK 2617	NA	NA	NA	NA	NA
	0.253244	0	0	0	0
	0	0	3	3	1
	0	0	0	0	0
	0	0	0	1	0
	0	0	0	0	0
	T				
Bathysuchus megarhinus DORCM G05067 i-v			-0.41217	-0.27598	-1.07893
	0.07573	NA	NA	0	0
	0	0	0	0	3
	3	1	0	0	0
	0	0	0	0	0
	0	0	1	0	0
	0	0	T		
Steneosaurus' heberti MNHN.F 1890-13		0.890399			-0.01369
	NA	NA	1.658176	1.346358	0
	NA	NA	NA	NA	0
	3	3	2	0	NA
	0	1	0	0	0

0 1 0 0 0
0 0 0 M

Steneosaurus' leedsi3 NHMUK R3806 -0.13525 -
0.12125 2.727678 -0.47503 0.033022-
0.32413 0 0 0 0 0
0 3 3 1 0
0 0 0 0 0
0 0 1 0 0
0 0 0 0 M

Steneosaurus' leedsi4 CAMSM
J1420 NA NA NA NA
1.129752 -
0.13289 0 0 0 0 0
0 3 3 1 0
0 0 0 0 0
0 0 1 0 0
0 0 0 0 M

Steneosaurus edwardsi3 NHMUK PV R3701 -0.03268 -0.06458
0.391777
-0.91565 -0.91757 -
0.61907 0 0 0 0 0
0 3 3 1 0
0 0 1 0 0
0 0 1 0 0
0 0 0 0 M

Steneosaurus edwardsi2 PETMG
R178 NA NA NA NA NA
1.888662 0 0 0 0
0 1 3 3 2
0 1 0 1 0
0 0 0 1 0
0 0 0 0 0
M

Lemmysuchus obtusidens2 NUMUK PV R3168 1.608351-0.2979 -
0.43627 0.07573 0.4976590.8615770 1
1 0 1 1 3
3 2 1 1 1

1 0 0 0 0
1 0 0 0 0
0 0 Ma

Machimosaurus buffetauti1 DFMMh F330 1.475017-0.41085 -0.09022 -
0.03442 NA NA 0 1 1
0 1 1 3 3
2 1 1 1 1
0 0 0 0 0
0 1 1 0 0
0 Ma

Steneosaurus' obtusidens1 CAMSM J65408 3.467846-0.35665 -
0.31268

-
0.47503 NA NA 0 1 1
0 1 1 3 3
2 1 1 1 NA
0 0 0 0 1
0 0 0 0 0
0 Ma

Steneosaurus' obtusidens2 DORCM G3939 0.484243-
0.39016 NA NA NA NA 0
1 1 0 1 1
3 3 2 1 1
1 NA 0 0 0
0 1 0 0 0
0 0 0 Ma

Steneosaurus' obtusidens3 OUMNH J40669 -0.6173
0.551504

-0.48571 -
0.69534 NA NA 0 1 1
0 1 1 3 3
2 1 1 1 NA
0 0 0 0 1
0 0 0 0 0
0 Ma

Machimosaurus sp.1	MJML K839	-0.20704	-0.66899	-0.85647	-
0.14458	NA	NA	0	1	1
	0	1	1	3	3
	2	1	1	1	NA
	0	0	0	0	0
	0	1	1	0	0
	0	Ma			
Steneosaurus' gracilirostris	MNHNL TU515				-
1.15064	0.440552	NA			
	-0.25473	NA	-		
1.0671	0	0	0	0	0
	0	NA	2	0	0
	0	0	0	1	0
	0	0	0	0	0
	0	0	0	0	
	OUT				
Indosinosuchus sp.	PRC-239	0.093883	0.275485	NA	-
1.0258					
	-0.97766	-			
0.88218	0	0	0	0	0
	0	3	3	1	0
	0	0	0	0	0
	0	0	0	0	0
	1	0	0	0	T
Platysuchus multiscrobiculatus		SMNS 9930		-0.51474	
	0.443034	NA	-1.0258	-1.40832	-
1.38468	0	0	0	0	0
	0	3	3	1	0
	0	0	0	1	0
	0	0	0	0	0
	0	0	0	0	T
Mystriosaurus laurillardi	NHMUK PV OR 14781		0.244242	-	
0.15145	NA	1.287412	0.243724	0.974297	0
	0	1	0	0	0
	3	3	2	0	0
	0	0	1	0	0
	0	0	0	0	0
	0	0	0	T	

Sericodon jugleri	NRM-PZ R.2337	1.239118	-0.12787	NA	-
1.68672	NA	NA	0	0	0
	0	0	0	3	3
	1	0	0	0	NA
	0	0	0	0	0
	0	1	1	0	0
	0	T			
Aeolodon priscus1	MNHN.F.CNJ 78	-0.3814	NA	NA	-
1.90702					
	-0.771	-			
1.00826	0	NA	NA	NA	0
	0	3	3	1	0
	0	0	0	0	0
	0	0	0	0	0
	1	0	0	0	T
Aeolodon priscus2	NHMUK PV R 1086	-1.60192	1.545134	NA	-
0.36488	NA	-			
1.29446	0	NA	NA	NA	0
	0	3	3	1	0
	0	0	0	0	0
	0	0	0	0	0
	1	0	0	0	T
Yvridiosuchus boutilieri1		OUMNH J.29850	-0.64807	-	
0.03686	NA	-0.14458	-0.80726	-	
0.64066	0	1	1	0	1
	1	3	3	2	1
	1	1	1	0	0
	0	1	0	0	0
	0	0	0	0	Ma
Yvridiosuchus boutilieri2	NHMUK PV OR 28611	-0.33012	-0.68472		
	0.503008	0.846801	NA	NA	0
	1	1	0	1	1
	3	3	2	1	1
	1	NA	0	0	0
	1	0	0	0	0
	0	0	0	Ma	

Yvridiosuchus boutilieri3 NHMUK PV OR 40127 -0.01217 -0.22096 -0.41155

-
0.14458 NA NA 0 1 1
0 1 1 3 3
2 1 1 1 NA
0 0 0 1 0
0 0 0 0 0
0 Ma

Lemmysuchus obtusidens1 GPIT-RE-0301a -0.92499 4.834471 -0.70817 1.94833 NA NA 0 1
1 0 1 1 3
3 2 1 1 1
NA 0 0 0 0
1 0 0 0 0
0 0 Ma

Machimosaurus hugii MG-25 0.562192 -0.80262
0.540084 1.507718 NA NA 0
1 1 0 1 1
3 3 2 1 1
1 NA 0 0 0
0 0 0 1 0
0 0 0 Ma

Machimosaurus rex ONM NG 5 1.618607 NA NA
2.939706 NA NA 0 1
1 0 1 1 3
3 2 1 1 1
NA 0 0 0 0
0 0 0 0 0
0 1 Ma

Machimosaurus buffetauti2 SMNS 91415 -1.13012 -0.55771 NA -0.47503 0.155683 0.804191 0 1 1
0 1 1 3 3
2 1 1 1 1
0 0 0 0 0
0 1 1 0 0
0 Ma

Machimosaurus sp.2	GPIT-RE-03037	-0.01178	-0.37609	-0.37447	
	0.626495	NA	NA	0	1
	1	0	1	1	3
	3	2	1	1	1
	NA	0	0	0	0
	0	0	1	0	0
	0	0	Ma		
Deslongchampsina larteti		OUMNH J.29851	-0.75063	-	
0.40588	1.207465	0.956954	-0.63553	-	
0.33153	0	0	0	0	0
	0	3	3	2	0
	0	0	1	0	0
	0	1	0	0	0
	0	0	0	0	S
Steneosaurus' bollensis1	GPIT-RE-				
9427	NA	NA	NA	NA	
	1.573467	1.652508	0	0	0
	0	0	0	3	3
	1	0	0	0	0
	1	0	0	0	0
	0	0	0	0	0
	0	M			
Steneosaurus' bollensis2		SMNS 51957	-0.75107	-	
0.10719	NA	-0.36488	-		
0.8035	NA	0	0	0	0
	0	0	3	3	1
	0	0	0	0	1
	0	0	0	0	0
	0	0	0	0	0
	M				
Steneosaurus' leedsi1		BRLSI GP1770a-e	0.162191	-	
0.05217	0.873775	-			
0.58519	1.674183	0.88808	0	0	0
	0	0	0	3	3
	1	0	0	0	0
	0	0	0	0	1
	0	0	0	0	0
	0	M			

Steneosaurus' leedsi2		LPP.M.37		-0.81217	-
0.17173					
	-0.60929	0.406189	NA	-	
0.69575	0	0	0	0	0
	0	3	3	1	0
	0	0	0	0	0
	0	0	1	0	0
	0	0	0	0	M
Steneosaurus edwardsi1	NHMUK PV R 2865			-0.75063	-0.45883 -
1.77103	0.07573	-			
0.12445	0.412653	0	0	0	0
	0	0	3	3	2
	0	1	0	1	0
	0	0	0	1	0
	0	0	0	0	0
	M				
Steneosaurus sp.1	MNHN specimen (no number)			-0.20704	0.217567
1.133312					
	-0.14458	-0.52036	-		
0.70087	0	0	0	0	0
	0	3	3	1	0
	0	0	NA	0	0
	0	0	1	0	0
	0	0	0	0	M
Steneosaurus sp.2	NHMUK PV R 4764	-0.44294	-0.51468	-0.65873	-
0.14458	NA	NA	0	1	1
	0	1	1	3	3
	2	1	1	1	NA
	0	0	0	0	1
	0	0	0	0	0
	0	Ma			
Steneosaurus' sp.3	NHMUK PV OR 47161			-0.77115	-0.645
0.416495					
	-				
0.58519	NA	NA	0	1	1
	0	1	1	3	3
	2	1	1	1	NA
	0	0	0	1	0

	0	0	0	0	0
	0	Ma			
Teleosaurus sp.	NHMUK PV R 6377	0.459628	0.064084	NA	
	0.846801	NA	NA	0	0
	0	0	0	0	3
	3	1	0	0	0
	NA	0	0	0	1
	0	0	0	0	0
	0	0	T		

APPENDIX S3.2

Dental Characters

1. Continuous Characters
   Note: continuous characters C1 to C4 follow that of Foffa et al. (2018a).

C1. Apicobasal crown height (CH). Measured as a straight length from the apex of the tooth to the base (crown-root juncture).

C2. Crown ratio (CR). Defined as the ratio between the apicobasal crown height (C1) divided by the diameter of the crown base.

C3. Lingual-labial curvature (CL or LLcufrv). Defined as the ratio between the length of the labial surface divided by the length of the lingual surface of the tooth.

C4. Crown angle (CA). Defined as the angle measured on the anterior/posterior view, using high-resolution photographs in ImageJ.

C5. Rostral length (RL) **(NEW)**. Defined as the total length of the rostrum, from the anterior-most premaxilla to the anterior orbital margin.

C6. Rostral width (RW) **(NEW)**. Defined as the width of the rostrum immediately anterior to the orbits.

2. Discrete Characters
   Note: all discrete characters follow that in Foffa et al. (2018a) unless otherwise specified.

D1. Labial-lingual compression of the tooth.

0. Absent

1. Weakly compressed
2. Strongly compressed

D2. Presence and size of true denticles (via Prasad & Broin, 2002; modified from Young et al., 2016 and Foffa et al., 2018a). Note, the terms ‘microziphodonty’ and ‘macroziphodonty’ are as follows in Foffa et al. (2017).

0. Absent
1. Incipient microziphodonty
2. Microziphodonty
3. Macroziphodonty

D3. Presence or absence of functionally serrated edges.

0. Absent
1. Present

D4. Distribution of denticles along the carinae.

0. Non-contiguous
1. Contiguous

D5. Presence of ‘pseudodenticles’.

0. Absent
1. Present

D6. Presence of a macroscopic anastomosed pattern (detailed, branching crenulations of enamel ridges on the apex of the tooth).

0. Absent
1. Present and well-developed

D7. Enamel ornamentation, lingual side (modified from Foffa et al., 2018a).

0. Absent
1. Largely absent, or present with weak apicobasal ridges
2. Present and consists of numerous, spaced defined apicobasal ridges
3. Present and consists of conspicuous, numerous, well-defined, closely packed apicobasal ridges.

D8. Enamel ornamentation, labial side (modified from Foffa et al., 2018a).

0. Absent
1. Largely absent, or present with weak apicobasal ridges
2. Present and consists of numerous, spaced defined apicobasal ridges
3. Present and consists of conspicuous, numerous, well-defined, closely packed apicobasal ridges

D9. Enamel ridges, relief (modified from Foffa et al., 2018a).

0. Absent or extremely low (absent macroscopically)
1. Low relief but macroscopically distinct, <0.5 mm
2. Medium relief, <1 mm

D10. Presence of absence of false denticles (ornamentation that interferes with the carinae).

0. Absent
1. Present

D11. Texture of enamel.

0. Smooth
1. 'Pebbled'

D12. Shape of tooth crown apex.

0. Sharp and pointed

1. Blunt and round

D13. Non-procumbent or procumbent dentition.

0. Present
1. Absent